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INDUSTRIAL NOTES..... 500


Another fast run was made by the Empire State Express on May 20. The run of 81 miles from Syracuse to Rochester was made in 71 minutes, and the 69 miles from Rochester to Buffalo in 69 minutes, while the run of 146 miles from Syracuse to East Buffalo was made in 141 minutes. At one point, between Batavia and Buffalo, a speed of 100 miles an hour is said to have been reached.

The tests of the new Worthington pumping engine at Marlborough, Mass., noted in our issue of May 18, were made by B. R. Felton, City Engineer. Mr. Geo. A. Stacy, Superintendent of Water-Works, and Mr. E. H. Foster, the latter representing the manufacturers of the pump.

The armored cruiser "New York," 8,150 tons displacement, made her official trial trip near Boston, on May 22. The contract speed was 20 knots; but in this trial she made 83.3 knots in 3 h. 57 m., an average of 21.09 knots per hour, and by so doing won $200,000 in premiums for her builders, the Cramps, of Philadelphia. The conditions were excellent for the trial, and the course was twice over a line 41.65 knots long. This record is claimed to place the "New York" ahead of all war ships in the world of over 5,000 tons displacement, though the English war ship "Blenheim" is said to have made 23 knots for 1 h. 4 m., when her boilers gave out. The "New York" came out of the trial in perfect condition in every particular, and made her record with about 135 revolutions. She will probably be completed and in commission by September next.

The plans for the proposed Mississippi River bridge at New Orleans, La., submitted to the War Department, provides, it is stated, for two shore spans of 610 ft. and a channel span of 1,070 ft. The width of the river is 2,290 ft., and the greatest depth of water 100 ft. The height of the bridge above high water will be 85 ft., and above low water of 103.7 ft. The location of the bridge is above 12-mile Point, opposite Boisbiane on the east bank, and Willswood Plantation on the west bank. E. L. Corthell, M. Am. Soc. C. E., of Chicago, is engineer.

Another step toward the tunnel under the East and North rivers, proposed by Mr. Austin Corbin, has been taken by the consolidation of the New York, New Jersey & Eastern, and New York & New Jersey Underground Ry. companies, under the name of the Brooklyn, New York & New Jersey Terminal Co. The object of the new company is to build the proposed railway tunnel from the Flatbush Ave. station of the Long Island R. R. in Brooklyn, underneath the East River, Manhattan Island and the North River, to the Pennsylvania R. R. station in Jersey City, a distance of about 3½ miles. It is designed to put up a big central station at Atlantic and Flatbush Aves. in Brooklyn, to which will be brought by branch lines passengers from the Brooklyn Elevated roads and the Long Island, who desire to reach Western and Southern points. At the Battery in New York a central station is to be established to gather in the passengers from the Manhattan Elevated systems. Mr. Charles M. Jacobs, Corbin Building, New York, N. Y., is the Chief Engineer.

The most serious railway accident of the week was a collision on the Jefferson Division of the Buffalo, Rochester & Pittsburg R. R., near Dubois, Pa., May 18. A freight train ran away on a long, heavy grade, and ran into a construction train. Four men were killed, and three of them were burned in the wreck.

A highway bridge over the Great Northern Ry., at St. Paul, Minn., was damaged, May 16, through one of the piers being knocked down by a derailed freight train.—An old highway bridge across the West Branch, at Bradford, N. Y., gave way under a team, May 19.—A trestle on the Chicago, Burlington & Quincy R. R., near Creston, Ia., was burned May 20.—A collision at Johnstown, Pa., on the Baltimore & Ohio R. R., wrecked two oil tank cars, which caught fire, and damaged an iron bridge by the heat.

The recent floods in the central and western states have done considerable damage to railway and highway bridges. The Union Pacific, Northern Pacific and Great Northern railways are said to have suffered severely.

The water power dam of the Saco Water Power Co., at Union Falls, Me., gave way May 23.—The dam near Alexandria, Minn., holding back the water of Ida and Miltona lakes, gave way May 18.

A peculiar case of rail breakage was recently discussed in a meeting of the "Verein fuer Eisenbahnkunde." On the Westerwald Railway, Germany, not less than 81 breakages of rails had been reported in a single day. Upon investigation as to the cause, it was found that on a very cold day the brakes of a 15-ton coal car had been left on through the carelessness of a brakeman. Consequently the wheels dragged, and a deep groove was worn into the tires. When at last the brake rod was broken, the hammer like action of the wheels at each revolution caused the fractures in the rails. This is further proved by the fact that the breakages occurred in pairs, or exactly opposite each other. The rails were of steel and 5⅛ ins. high, laid upon horizontals instead of cross-ties. The maximum grades were 1.66%.

The long delayed Louisville and Jeffersonville bridge across the Ohio River at Louisville, Ky., will be completed at once, it is stated. Contracts for the bridge were let to the Phoenix Bridge Co., of Phoenixville, Pa., in 1889, and work was at once begun and continued until the early part of 1891, the foundation work being practically completed, when the Phoenix Bridge Co. began suits for money owed it. These suits have been pending, and no work done since. It is stated that the money has now been secured, and the amount due the Phoenix Bridge Co. paid, and, in addition, a further contract for completing the bridge let to the same company. Report states that the necessary money is being furnished by the Cleveland, Cincinnati, Chicago & St. Louis R. R. Co., which has voted bonds for the construction of a branch to Louisville, Ky. A brief description of this bridge was published in our issue of April 26, 1890.

Bids for the large lock of the Colbert Shoals Canal, about 22 miles below Florence, Ala., on the Tennessee River, have been opened by the Government engineers. The designs call for a lock 375 ft. long and 80 ft. wide, with a 25 ft. lift, and the bids ranged from $305,767, to $624,034. The Colbert Shoals Canal will be eight miles long, 150 ft. wide, and 7 ft. minimum depth. It is estimated to cost $3,000,000, and it is stated that construction will begin as soon as the contract for the lock is let. The work will be in charge of Capt. Geo. W. Goethals, Engineer in Charge of the Tennessee River Improvements.

The Minnesota Canal Co., of Duluth, Minn., has been organized with a capital of $25,000,000 for the purpose of navigation and power, by building a canal, 24 miles long, from the upper waters of the St. Louis River to the bluff back of the city of Duluth, by which a head of 630 ft. above Lake Superior will be obtained, with a capacity of 100,000 horse-power. The distribution of power will be by steel pipes, 6 ft. in diameter, with branches to the various points requiring power, which will be developed through water engines and impact wheels. The president and chief engineer is Mr. Henry C. Spaulding, and the consulting engineers are Messrs. G. D. Hiscox, of New York; Milton Weston, of Chicago, and E. Kuichling, of Rochester, N. Y. Mr. H. Olmstead is chief of staff, and Messrs. E. H. Spaulding, H. I. Chapin and H. E. Abbot are the division engineers. The offices of the company are in the New Mesaba Block, Duluth, Minn., The City Council of Duluth has granted the company the right to lay its pipes in the streets of that city. The proposed capacity of this power plant is 3,500 cu. ft. of water delivered at Duluth per second.

A 6 × 8-ft. papier mache model of the Sudbury and Cochituate drainage areas of the Boston Water-Works is to be exhibited by the Boston Water Board at the World's Columbian Exposition, according to reports. The model has a vertical scale of ½ in. to 20 ft. and a horizontal scale of 1 in. to 10,000 ft. Datum is taken at 140 ft. above sea level.

The Chignecto Ship Railway Co., according to a late circular issued by the directors, is endeavoring to obtain from the Canadian government a further extension of time. The prospectus of March 13, which asked for subscriptions to $1,400,000 6% first preference mortgage bonds to complete the work, only secured offers for $500,000, and the attempt was abandoned for the present. The act authorizing the Canadian subsidy for the ship railway expires on July 1.

The long distance transmission plant of the San Antonio Light & Power Co., Pomona, Cal., has been in successful operation for six months, transmitting power a distance of 28 miles. The hydraulic part of this plant was installed by the Pelton Water Wheel Co., and includes that company's new regulating apparatus, which controls the speed of the wheel under exacting conditions to variation in load on the generators. A Pelton wheel, running a set of circular saws at the mill of the Red Cross Lumber Co., in the northern part of California, is operated under a vertical pressure of 485 ft. The saws require to drive them through the log at full feed 125 HP., and take about seven cuts per minute, thus varying from full load, namely, 125 HP., to only what is required to drive the saws running free. During this operation the variation in speed is not perceptible. One of the most valuable features claimed for the regulator is that it is positive in movement and there is no danger whatever of its racing, thus admitting of its being geared so as to be extremely sensitive.

The James Forrest Lectureship Fund of the Institution of Civil Engineers in London originated in a manner not known to many American engineers, though nearly all are familiar with the name of the man who has so long and so worthily filled the office of Secretary to the Institution. The first lecture under this bequest was delivered this month by Dr. Wm. Anderson, D. C. L., F. R. S., M. Inst. C. E., and, in commencing, he explained the origin of the fund as follows: During the session of 1889 the Council decided to have a portrait of Mr. James Forrest painted and presented to the Institution, and this presentation was made Nov. 11, 1890. It was an excellent likeness, and many of the members present expressed a desire to have it engraved. A committee was formed outside of the Council, funds were rapidly collected, and an excellent engraving was made by Mr. Thomas Faed, R. A., and distributed to members. The surplus subscriptions, amounting to $2,500, were placed at the disposal of Mr. Forrest himself, and he determined that it should be devoted to the establishment of the above named lectureship, the Council to select the lecturer and determine the subject. It is a pleasing memorial, both of the deserved popularity of the Secretary and of his life-long devotion to the Institution itself.

The first Russian water-works congress was held on March 21 last at Rouski, Wedomosti. The paper that attracted the most attention was on the relation between water-works and consumers. Mr. J. J. Platts, the author, said that there were in Russia 56 water-works, supplying over 5,000,000 people; but that there was no law strictly defining the rights of companies supplying water, and of consumers themselves. Special laws are required, and the outcome of this congress was the order to the permanent committee to formulate necessary laws and submit the same to the next Congress for approval.

Mexican railways, according to a late report published by the Mexican government, figure as follows: In 1880 there were 19 railways in the republic with a total length of 654 miles; in 1892 there were 89 roads with an aggregate length of 6,546 miles. In both cases only railways built under federal concessions are counted. The total length of all kinds of railways in Mexico in 1892 is given as follows:

| | Miles. |
|---|---|
| Built under federal concessions | 6,546.0 |
| City railways | 219.5 |
| Suburban railways | 114.7 |
| Private railways | 44.0 |
| Railways on the Decauville system | 142.6 |
| Total | 7,066.8 |

The traffic of the roads is compared as follows for 1880 and 1892:

| | No. passengers. | Freight: tons. | Earnings. |
|---|---|---|---|
| 1880 | 9,600,982 | 364,398 | $6,317,908 |
| 1892 | 19,581,605 | 2,734,430 | 21,019,961 |

## THE QUAKER CITY AND NORTHEASTERN ELEVATED RAILWAYS, PHILADELPHIA, PA.

There is probably not a city of its size and population in the United States where the means of rapid transit from one section to another are so slow and uncertain as in Philadelphia. This is owing in a large measure to the vigorous opposition which the street railways and principal steam railways have offered to the construction of elevated railway lines or other systems of rapid transit suitable to the growth and development of the city. For some months the Northeastern and the Quaker

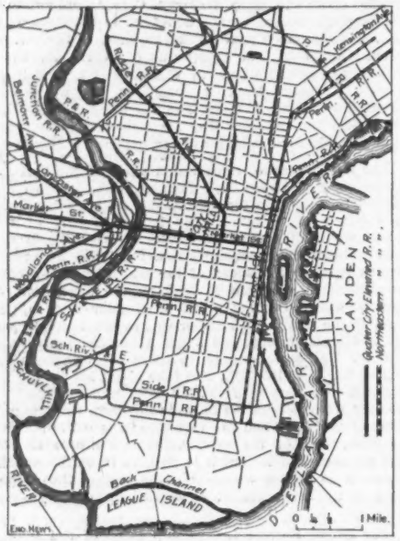



Fig. 1. Map Showing Routes of the Quaker City and Northeastern Elevated Railways, Philadelphia, Pa.

City elevated railways have been endeavoring against this opposition to construct their several proposed lines, and have succeeded so far as to actually begin work on a portion of the Front St. line. These two companies were chartered under the general railway laws of Pennsylvania, which their legal advisers, after a careful study, considered ample to authorize the construction of elevated railways in the streets of Philadelphia, provided the consent of the city government could be had. This was obtained by the Northeastern Elevated Ry. Co. in June, 1891, and by the Quaker

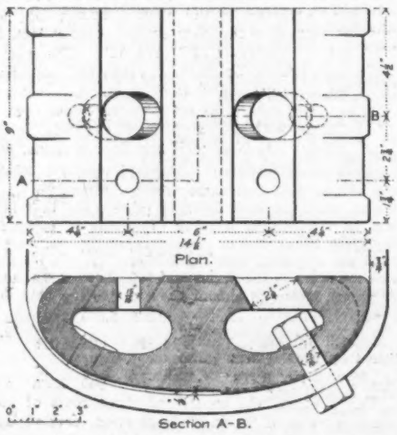



Fig. 4. Enlarged Details of Expansion Pocket.

City Elevated Ry. Co. in February, 1892. The companies have, however, been attacked on the question of their legal existance and the legal battle has not yet been decided. At present there is an injunction preventing work on the Market St. line, but construction is in progress on the Front St. line, as before stated, although there are injunctions preventing work in front of certain isolated properties.

The routes of these two lines are shown in the accompanying map. The ordinance authorizing the construction of the Northeastern Elevated Ry. provides for a double track road from that part of the county line known as Cheltenham Ave., over property to be purchased by the company, to Butler and Mascher Sts.; on Mascher St. to Tusculum St. to Kensington Ave., on Kensington Ave. to Lehigh Ave., on Lehigh Ave. to Amber St., on Amber St. to Front St. and on Front St. to Pollock St.

Also a branch from Lehigh Ave. and Emerald St. northeast on Emerald St. to the junction of

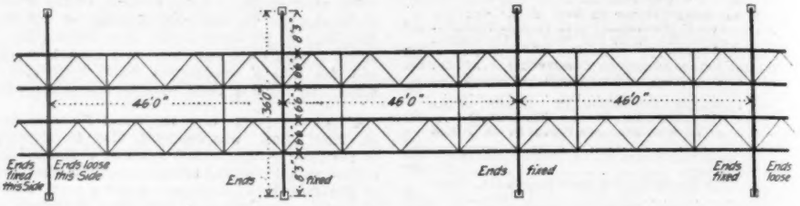



FIG. 2. DIAGRAM SHOWING ARRANGEMENT OF GIRDERS AND LATERAL BRACING.

Emerald St. and Erie Ave.; thence over private property to be purchased by the company, to Frankford Ave. near Butler St.; thence on Frankford Ave. to Margaretta St.; thence over private property to be purchased by the company, to Cedar St.; thence on Cedar St. to Bridge St.; and thence over private property to be purchased by the company, to Tacony and Holmesburg. This route is shown by the dotted line on the map. The routes of the Quaker City Elevated Ry. Co.'s lines are shown by full lines and in detail are as follows: From Front and Market Sts. to the intersection of 9th and Market Sts.; thence over 9th St. to the junction of 9th and Vine Sts. and Ridge Ave.; thence over Ridge Ave. to Lehigh Ave. Also a branch from the intersection of 9th and Market Sts., over Market St. to Juniper St.; Juniper St. to South Penn Square; South Penn Square to Broad St.; Broad St. to Market St.; Market St. to the county line; from Lancaster Ave. at its junction with Market St. to the intersection of Lancaster Ave. and 44th St.; 44th St. from Lancaster Ave. to Fairmount Park; from the junction of Woodland Ave. and Market St. over Woodland Ave. to the county line. The ordinances provide for a clear headway of 14 ft. over streets and of 20 ft. over other railway lines.

In Figs. 2 to 5 are shown the details of the elevated structure now being erected on Front St. Briefly it consists of four longitudinal plate girders of 46 ft. span riveted, except at expansion joints where they are supported in pockets, to transverse plate girders supported by two columns placed just within the curbs on each side of the street, and 36 ft. apart c. to c. These longitudinal girders are made up of webs 50¾ ins. deep and ⅜-in. thick, with top and bottom chord angles 6×4×¾ ins. and 3½×3½×5-6 in. angle stiffeners and ¾-in. filler plates. They are placed 6 ft. 6 ins. apart c. to c., and the outside girders are 8 ft. 3 ins. from the center line of the columns. This extra distance between the outer girders and the columns was designed to allow the construction of a third track if the traffic should demand it. The lateral bracing consists of 3½×3½×⅜ ins. angles arranged as shown in the diagram plan, Fig. 2. This diagram also shows the arrangement of the fixed and expansion ends.

The fixed ends of the girders are faced and riveted to the cross girders by 4×4⅜-in. angles. For the expansion ends a novel form of pocket is used to support the girders. This pocket is shown in position on the drawing of the cross girder in Fig. 3

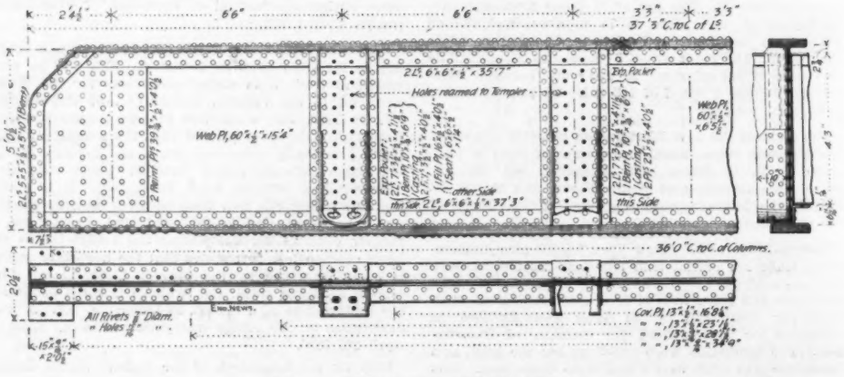



FIG. 3. DETAILS OF CROSS GIRDER.

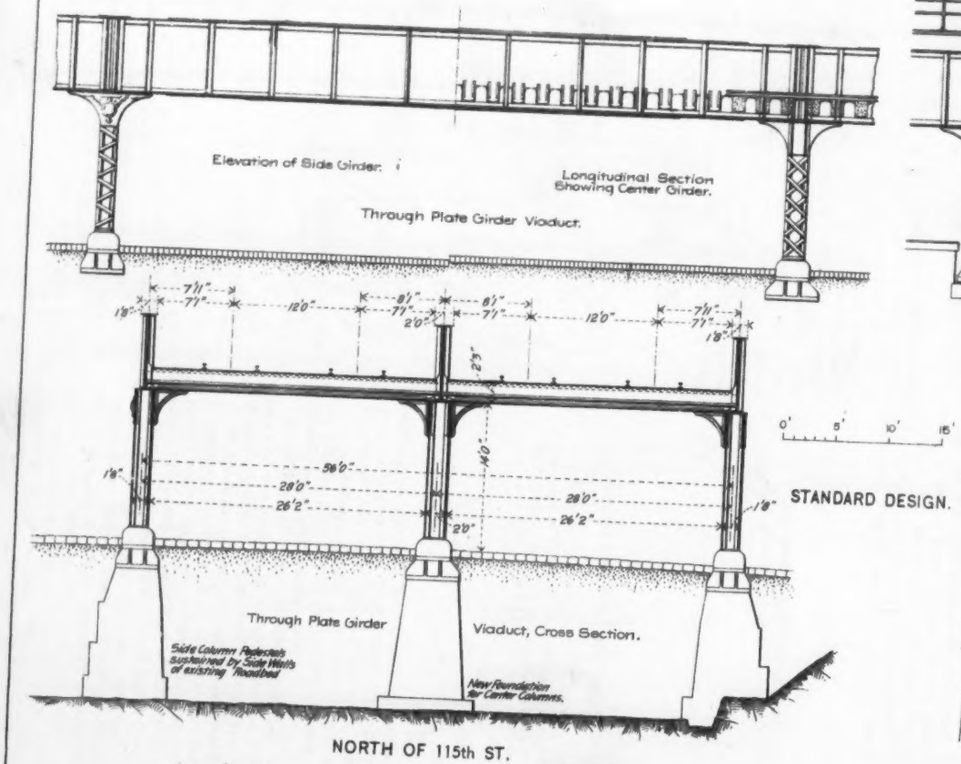
The columns supporting the cross girders consist of channels latticed together and have attached to their inner sides at the top a bracket projecting underneath and supporting the cross girder. The foundations are shown in Fig. 5.

It has not been definitely decided what the character of the floor system will be. If possible a solid metal floor will be used, and in any case it will be made as solid and safe as possible by the use of heavy guard rails. It will be seen from the illustrations that an uncommonly substantial and permanent structure is intended throughout. We are indebted to Mr. C. W. Buchholz, M. Am. Soc. C. E., President of the Northeastern Elevated Ry. Co., for the matter from which our illustrations have been prepared.

## THE VALUE OF A WATER ANALYSIS.*

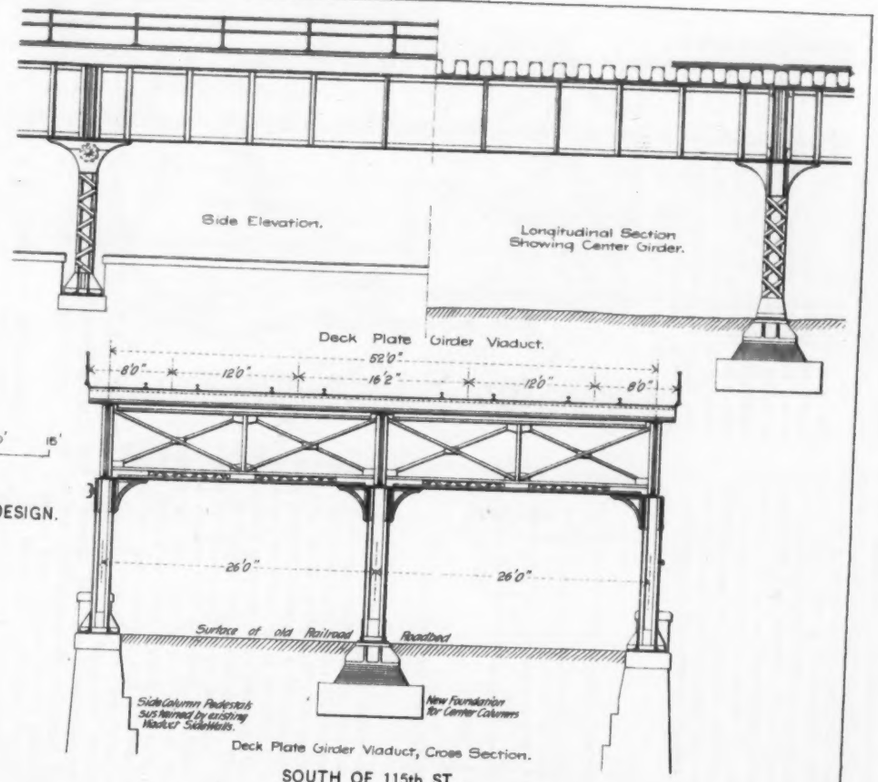
A water analysis is really not an analysis at all, properly so-called, but is a series of experiments undertaken with a view to assist the judgment in determining the potability of the supply. The numerical results of a water analysis are not only unintelligible to the general public, but are not always capable of interpretation by a chemist, unless he be acquainted with the surroundings of the spot whence the sample was drawn, and be posted as to the analytical methods employed. It is very common for water to be sent for analysis, with the request that an opinion be returned as to its suitability for potable uses, while at the same time all

*Abstract of a lecture by W. P. Mason, Rensselaer Polytechnic Institute, Troy, N. Y.

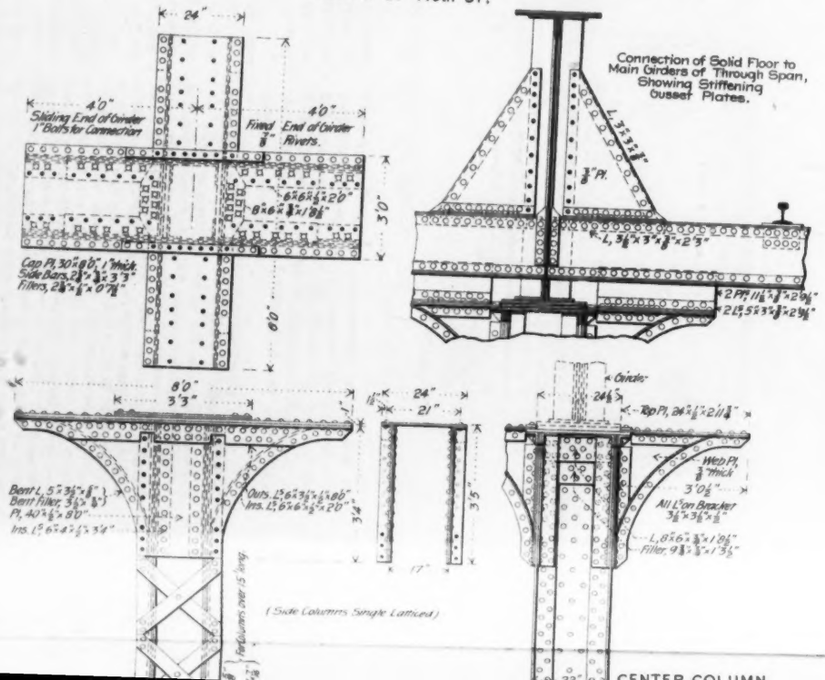

Elevation of Side Girder.
Longitudinal Section Showing Center Girder.
Through Plate Girder Viaduct.
Through Plate Girder
Viaduct, Cross Section.
Side Column Pedestals sustained by Side Walls of existing Roadbed
New Foundation for Center Columns.

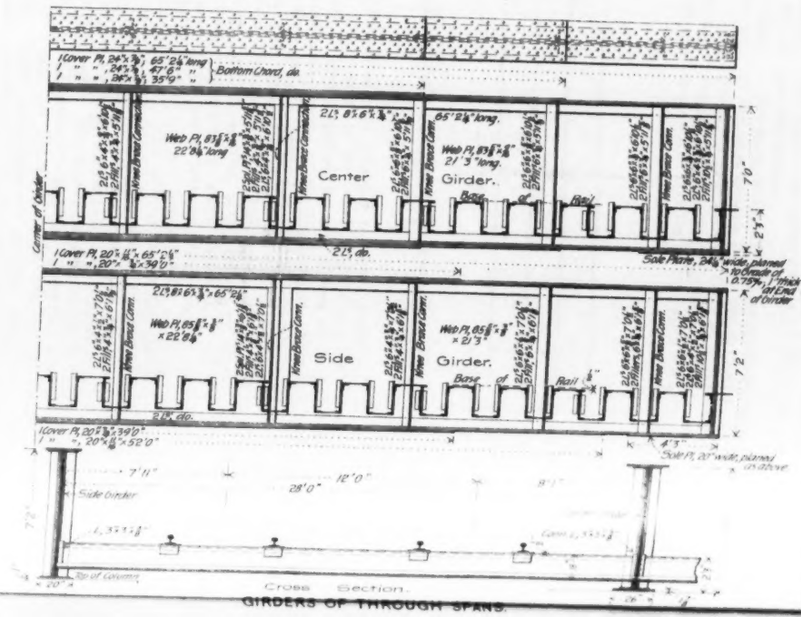
NORTH OF 115th ST.

STANDARD DESIGN.

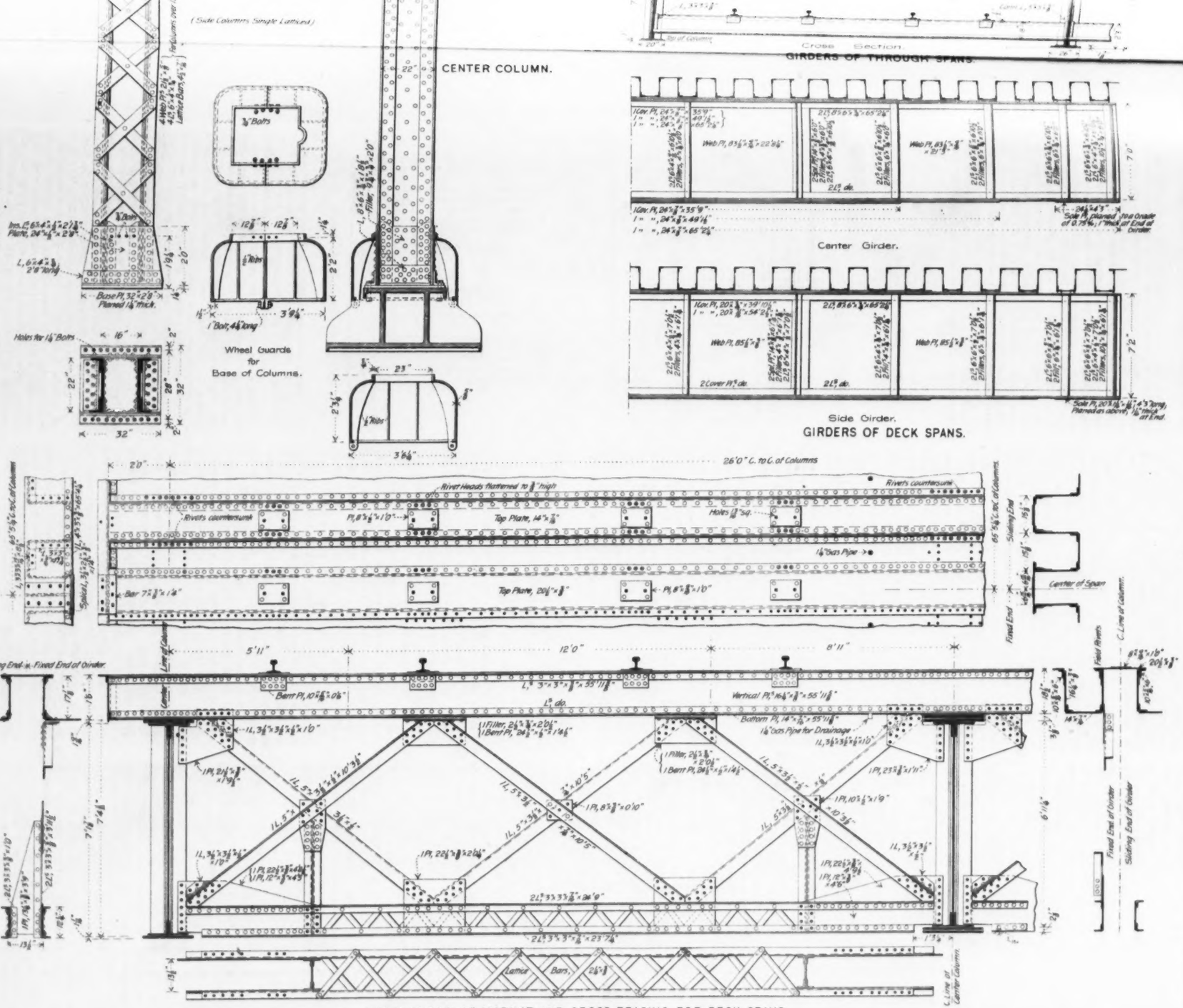

Side Elevation.
Longitudinal Section Showing Center Girder.
Deck Plate Girder Viaduct.
Surface of old Railroad Roadbed
Side Column Pedestals Sustained by existing Viaduct Sidewalls.
New Foundation for Center Columns
Deck Plate Girder Viaduct, Cross Section.

SOUTH OF 115th ST.


Connection of Solid Floor to Main Girders of Through Span, Showing Stiffening Gusset Plates.
Sliding End of Girder
Fixed End of Girder
Rivets.
Side Columns Simple Latticed
CENTER COLUMN




GIRDERS OF THROUGH SPANS.


CENTER COLUMN.
Wheel Guards for Base of Columns.
Cross Section.
GIRDERS OF THROUGH SPANS.
Center Girder.
Side Girder.
GIRDERS OF DECK SPANS.
SOLID FLOOR OF VIADUCT AND CROSS BRACING FOR DECK SPANS.

# FOUR TRACK STEEL VIADUCT ON PARK AVENUE, NEW YORK CITY; NEW YORK CENTRAL & HUDSON RIVER R. R.

Walter Katte, Chief Engineer.

CHAS. HART & SONS, LITHS., 39 VESEY ST., N. Y.

information as to its source is not only unfurnished but is intentionally withheld, with a view of rendering the desired report unprejudiced in character. Such action is not only a reflection upon the moral quality of the chemist, but it seriously hampers him in his efforts to formulate an opinion from the analytical results.

For instance, a large quantity of common salt is a cause for suspicion when found in drinking water, not because of any poisonous property attaching to the salt itself, but because it is usually difficult to explain its presence in quantity, except upon the supposition of the infiltration of sewage; yet an amount of salt sufficient to condemn the water from a shallow well in the Hudson valley could be passed as unobjectionable if found in a deep-well water from near Syracuse, N. Y. A knowledge of the history of the water is no less important in order to interpret the remaining items of a water analysis. Some time since a water was sent from Florida to this laboratory for examination, and was found to contain 1.18 parts "free ammonia" per million. Much "free ammonia" commonly points to contamination from animal sources, and had it not been known that the water in question was derived from the melting of artificial ice made by the ammonia

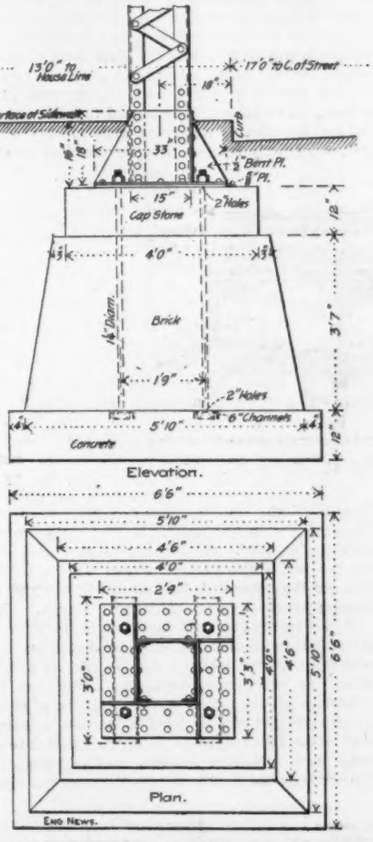



Fig. 5. Details of Foundations for Columns.

process, the enormous quantity of ammonia found would have condemned it beyond a peradventure. As it was, the water was pronounced pure, the other items of the analysis having been found unobjectionable.

Analytical results which would condemn a surface-water are unobjectionable for water from an artesian well, for the reason that in the latter case high figures in "free ammonia," "chlorine," or "nitrates" are capable of an explanation other than that of sewage infiltration. Even though such water should have, at a previous period, come in contact with objectionable organic waste material, yet the intervening length of time and great distance of underground flow would have furnished abundant opportunity for thorough oxidation and purification.

"Deep" samples taken from the same lake, at the same spot and depth, will greatly vary in analytical results if the temperature of the water at the several dates of sampling should be markedly different, owing to the disturbing influence of vertical currents.

Again, suppose it is desired to determine whether or not the water of a large stream is so contaminated with up-stream sewage as to be unfit for a town supply. An analysis of the water taken from the site of the proposed in-take would very probably be valueless, because the enormous dilution to which the admitted sewage would have been subjected would remove from the analytical results everything of an absolute character. Examinations of any real value in such cases should always be of a comparative nature. Samples should be taken above and below the point of contamination and again at the proposed in-take. If the difference between the first and second samples, which is a measure of the pollution, be maintained, or nearly so, at the point of in-take, then the water should be condemned no matter how completely the analytical results fall within the limits of the so-called standards of organic purity.

As Nichols has well said, "It is a great mistake to suppose that the proper way to consult a chemist is to send a sample of water in a sealed vessel with no hint as to its source. On the contrary, the chemist should know as much as possible as to the history and source of the water, and, if possible, should take the samples himself." In the taking of samples for so important a matter as a town supply, the chemist should unquestionably personally superintend their collection; but, for individual outlying waters, printed instructions have to be frequently depended upon. Those issued from this laboratory are as follows:

Directions for Taking a Water Sample.—Large glass-stopper bottles are best for sampling, but as they are seldom at hand, a two-gallon, new demijohn should be employed, fitted with a new soft cork. Be careful to notice that no packing straw or other foreign substance yet remains in the demijohn, and thoroughly rinse it with the water to be sampled. Do not attempt to scour the interior of the neck by rubbing with either fingers or cloth. After thorough rinsing, fill the vessel to overflowing so as to displace the air, and then completely empty it.

If the water is to be taken from a tap, let enough run to waste to empty the local lateral before sampling; if from a pump, pump enough to empty all the pump connections; if from a stream or lake, take the sample some distance from the shore, and plunge the sampling vessel a foot and a half below the surface during filling, so as to avoid surface scum.

In every case fill the demijohn nearly full, leaving but a small space to allow for possible expansion, and cork securely. Under no circumstances place sealing-wax upon the cork, but tie a piece of cloth firmly over the neck to hold the cork in place. The ends of the string may be afterwards sealed if necessary.

Bear in mind, throughout, that water analysis deals with material present in very minute quantity, and that the least carelessness in collecting the sample must vitiate the results. Give the date of taking the sample, and as full a description as possible of the soil through which the water flows, together with the immediate sources of possible contamination.

## FOUR-TRACK STEEL VIADUCT IN NEW YORK CITY; NEW YORK CENTRAL & HUDSON RIVER R. R.

(With inset.)

The elevation of the four tracks of the New York Central & Hudson River R. R. along Park Ave., New York city, between 110th St. and the Harlem River, as noted in our issue of April 13, will be a most interesting piece of engineering work, especially in view of the uninterrupted maintenance of the heavy traffic which must be provided for during its construction. This four-track line, which extends from Forty-second St. to Mott Haven junction, at 149th St., north of the Harlem River, about six miles, forms the approach by which the New York Central & Hudson River R. R., the New York & Harlem R. R. and the New York, New Haven & Hartford R. R. reach the Grand Central station (terminal) at Forty-second St. The line is straight, following the line of Park Ave. to the river. At the Grand Central station the tracks are on the street level, and after passing through the yards, which extend from Forty-fifth St. to Fifty-third St., they are depressed below the street level, with masonry retaining walls on each side, and are crossed by iron foot bridges, to Fifty-sixth St., where the two outer tracks enter single-track tunnels, while the two middle tracks enter a double-track tunnel. There are openings for ventilation and for refuges in the walls between the tunnels, and there are shafts at frequent intervals over the center of the middle tunnel. Part of this latter is practically a depressed road, having long stretches of open cut with brick walls and iron struts. At Ninety-sixth St. the tunnels end, and there is a cut to Ninety-eighth St., where begins an embankment with heavy masonry retaining walls, leaving a roadway on each side along the base, and having arched subways or iron bridges for crosstown streets. This continues to 115th St. and is followed by another cut with masonry walls extending to 130th St., where the tracks are again at the street level, and curve eastward to the double-track low-level drawbridge across the Harlem River.

This Harlem River drawbridge has been a serious obstruction to the railway traffic, and the railway company decided to build a high-level bridge. As the government is constructing the Harlem ship canal to afford greater facilities for navigation between the Hudson and East rivers by a short cut, the War Department required that this bridge should also have a drawspan, which, however, will not require to be opened frequently, as it will leave a headway of 24 ft. above high-tide level over two channels 100 ft. wide in the clear at right angles to the stream. The drawspan will be 389 ft. long c. to c. of end bearings. In view of the enormous traffic over the line (nearly 500 train movements in each 24 hours) the company decided to continue the four tracks over the drawbridge and up to 149th St. Junction. The drawbridge will be a notable structure in a great many ways, and we shall probably present the drawings of it in a later issue.

This change of the bridge elevation necessitated a change of grade on both sides of the river. On the south side this will be effected by the construction of a four-track steel viaduct commencing at 110th St. and rising by a uniform grade of 40 ft. per mile to 116th St., north of which the present cut will be filled in, giving Park Ave. its full width of 110 ft. between curbs, obstructed only by the three rows of columns for the new viaduct. On the north side of the river the approach to the bridge will be partly elevated viaduct, and partly embankment, with earth slopes and masonry retaining walls, having plate girder bridges over the streets. The line will descend by a grade of 37 ft. per mile, reaching the present grade at 149th St., at the junction of the Hudson River and Harlem divisions.

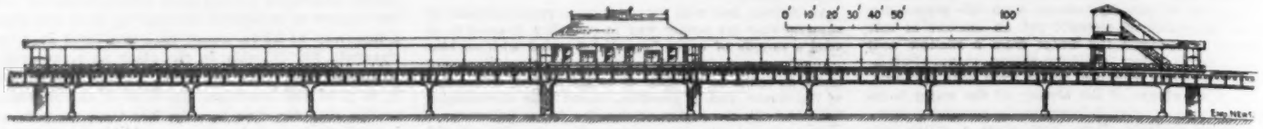
The part of the work which we illustrate this week is the steel viaduct from 110th St. to the Harlem River bridge. It will be a four-track structure of the plate-girder type, in three lines of girders with a solid floor of corrugated type, and carried on three rows of built-up steel columns. The viaduct was designed by Mr. Walter Katte, Chief Engineer of the New York Central & Hudson River R. R.; the working details and computations were elaborated by Mr. Geo. H. Thomson, Engineer of Bridges, and Mr. J. D. Wilkens, Constructing Draftsman. The work will be done under the supervision of the "Board for the Improvement of Park Ave. above 106th St.," appointed by the Mayor under authority of Chapter 339, Laws of New York, approved April 19, 1892. Mr. Walter Katte is one of the commissioners so appointed, and is also the Superintending Engineer of the Board; Mr. Geo. F. Boulard is Chief Assistant Engineer. Proprosals for the work were opened by the Board on May 4, as noted in our issue of May 11, and the contract for three sections has been awarded to the Elmira Bridge Co., and for one section to the New Jersey Steel & Iron Co. The contracts amount to $1,474,000. The work is to be commenced by Sept. 1, 1893, and completed by Sept. 1, 1894. The work under this contract includes everything above the base castings of the columns, with the exception of the rails and the track proper. It is divided into four sections, with quantities as shown in the accompanying table:

| | Sec. No. 1, | Sec. No. 2, | Sec. No. 3, | Sec. No. 4, | Total. |
|---|---|---|---|---|---|
| | 1,873 ft. | 1,570 ft. | 1,063 ft. | 1,883 ft. | 6,409 ft. |
| Columns, net tons.... | 332 | 330 | 285 | 350 | 1,297 |
| Girders, " .... | 1,720 | 1,450 | 1,000 | 1,718 | 6,888 |
| Bracing, " .... | 93 | 46 | 58 | 121 | 318 |
| Floor system, " .... | 2,659 | 2,200 | 2,645 | 2,853 | 10,357 |
| Drainage pipes, lin. ft. | 230 | 740 | 1,010 | 790 | 2,770 |
| Gutters, galv. iron, lin. ft. . . . . | 1,000 | 3,070 | 5,070 | 3,680 | 12,820 |
| Railings, lin. ft..... | 2,380 | ... | ... | ... | 2,380 |
| Concrete, cu. yds..... | 12 | 36 | 33 | 115 | 196 |
| Wheel guards (cast), tons . . . . . | 10 | 30 | 22 | 37 | 99 |
| Asphalt coating, sq. ft. | 500 | 1,500 | 1,440 | 2,075 | 5,515 |

The viaduct will consist of three rows of steel plate girders of 65 ft. average span, carried upon three rows of steel columns, and without any transverse girders. South of 115th St. it will be a deck structure, with cross bracing beneath the floor. North of 115th St. it will be a through structure, and no cross bracing will be used, the solid floor forming practically a continuous bracing and being connected to the girders by heavy gusset plates. No change is made in the floor, which is riveted to brackets riveted to the webs of the girders until it is high enough to be carried on the top chords of the girders. In the deck structure the columns are

26 ft. apart c. to c., while for the through structure they are 28 ft. apart c. to c. The columns are spaced on an average of 65 ft. 5¼ ins. c. to c., longitudinally.

The columns are of rectangular section, 16×22 ins., built up of angle irons 6×4×⅝ ins., with web plates 21½ ins. wide and ⅝ in. thick on two sides, and lattice bars 4½×7-16 in. on the other two sides. The middle columns will have brackets




LONGITUDINAL SECTION OF PARK AVE. VIADUCT, NEW YORK, AND ELEVATION OF 125TH ST. STATION; NEW YORK CENTRAL & HUDSON RIVER R. R.

on all four sides, while the outer columns will have them on three sides only. Cast iron wheel guards ½ in. thick will be bolted to the bases of the columns. These castings are to be dipped at the works for five minutes in a bath of natural asphalt, coal tar and heavy oil, at a temperature of 300° F. The pocket in the foot of each column will be filled with concrete made of the best American Portland cement, and clean, sharp,coarse bank sand in proportions of 1 to 1; the concrete to be rounded off and coated on top with asphalt roofing cement.

The construction of the girders is clearly shown by the drawings on our inset sheet. They are 7 ft. deep over the chord angle irons, and the side and middle girders are 20 ins. and 24 ins. wide, respectively, over the chord plates. The chord angles are of unusual size, 8×6×⅝ ins. The side girders have web plates ⅝ in. thick, and the middle girders have web plates 9-16 in. thick. In some cases the spans are 52 ft. 8⅝ ins. only, and the side and middle girders of these spans have ⅝-in. and ½-in. web plates, the depth of girder and width of chords being the same. All rivets in the girders will be ⅞ in. diameter.

The floor consists of transverse troughs of rectangular section, built up of steel plates and angles, as shown in detail. The troughs are 17⅛ ins. deep, 15 ins. wide, and the full length between girders. The rivets in the floor will be ¾ in. diameter. The floor will be riveted up at the shops in sections not exceeding 8 ft., and the ends then faced up to the precise length indicated by the plans. The ends of the troughs will be closely cut out and matched to fit the stiffeners of middle and side girders. The top and bottom plates of the troughs on curves will be manufactured to radial lines, with edges sheared and then planed, or the plates may be cut "bias" in a planer. On the deck spans the ends of the troughs will be closed by a steel plate.

Each trough will be drained by heavy 1¼-in. gas pipe, screwed into the bottom plate, about midway between the side and center girders. These pipes will discharge into galvanized iron gutters weighing not less than 1½ lbs. per sq. ft., riveted with galvanized rivets and well soldered. The gutters will be 6 ins. wide and 4 ins. high, suspended from the solid floor by galvanized wrought iron straps 1½×3-16 ins., screwed to the ironwork at intervals of 30 ins. They will be continuous for the length of one span, with a fall of not less than 5 ins. in 100 ft. Generally they will be 5 ins. below the bottom plates of the floor, and run parallel with the line of the viaduct. At each center column the water will be drawn from the gutters with 4-in. wrought iron leaders, forming a Y, and a single 4-in. pipe fastened to the column by straps will carry the water to a tile sewer placed below the top of masonry foundations. All elbows, Y's and bends will be of malleable iron.

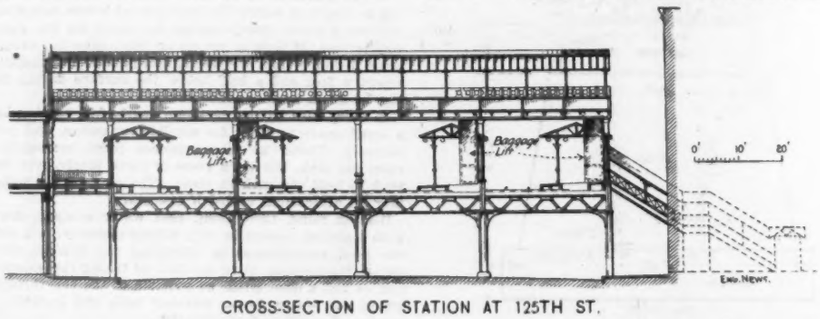
The steel will be made by the open-hearth process, from raw material within the Bessemer limit of phosphorus .1% and sulphur .05%, and the finished material must not show more than .08% phosphorus, .06% sulphur and .40% manganese. Test strips, cut lengthwise, are to show an ultimate tensile strength of not less than 58,000 lbs. or more than 65,000 lbs., with an elastic limit of not less than 38,000 lbs. per sq. in. and an elongation of 28% and 24% in 8-in. lengths for plates under and over 36 ins. in width. All steel must withstand such punch and forge inspection as may be sufficient to try the temper, soundness of the material must show (upon cutting out) no crystalline appearance.

Wrought iron may be used in the columns for the fillers, lattice bars and side brackets; in the girders for the fillers under the ends of the troughs; and for the cross bracing, frames and the knee braces. The wrought iron is specified to have an ultimate strength of 48,000 lbs. per sq. in., an elastic limit of 26,000 lbs., and an extension in 8 ins. of 15% along the grain and 80% of this across the grain. Rivet iron is to be soft, and to stand bending double cold, without fracture. All other wrought iron to bend 180° with an inner radius of 1½ times the thickness of the piece, without visible fracture. The cast iron is to be gray and tough, and the contractor must furnish test bars 1 in.×1 in. and 5 ft. long, cast in sand molds from every heat. Such bars must sustain a test load of 500 lbs. suspended in the center, 4 ft. 6 ins. clear between supports. Both surfaces coming in contact will receive one coat of black mineral paint before being riveted together at the shop. All work is to receive one protective coat of black paint at the shop, and a finishing coat of black paint after erection. A black asphalt paint is used by the New York Central R. R. for all its metal bridges.

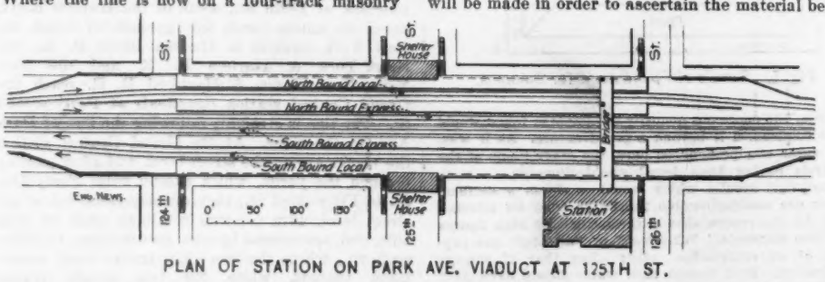
Where the line is now on a four-track masonry viaduct, a double-track timber trestle will be built along each side of this viaduct to carry the traffic, while the old structure is being removed, and the new steel viaduct erected. The trains will swing out onto these trestles at 105th St. and swing in again to the present tracks in open cut at 116th St. The foundations for the center columns between 115th St. and the south line of 130th St., where the present line is in a cut with masonry retaining walls, cannot be built until the elevated structure is erected, and the railway traffic transferred from its present depressed roadbed to the new viaduct. As the center columns cannot, therefore, be erected until the rest of the viaduct is entirely completed, the line of center girders will be temporarily sustained upon timber trusses spanning the cut. These trusses will be built and erected by the railway company, and preparations are now being made for erecting them. After the traffic has been transferred to the viaduct, the track in the depressed road will be taken up, the foundations built for the center columns, and the columns erected after an interval of seven days to allow for the setting of the cement in the foundations and under the base castings. The contractor will be required to perform the work of erection without interfering with the railway, and must provide all erecting plant and falsework.

The track will be laid with the New York Central standard 100-lb. rails, resting on steel tie-plates 8×12 ins. and ½ in. and 9-16 in. thick, with four bolt holes. The rails will be bolted through to the plates and troughs, no ties being used. Holes ⅞ in. square, accurately spaced, will be punched in the top plates of the troughs, for the bolts securing the track bolts to the rails. Harvey grip-thread bolts will be used. Where tracks are laid on curves the rail plates or base plates will be thickened under the outer rails and planed to the proper inclination for the superelevation of the rails. The tops of the rail plates will be brought to the established grade elevations, so that the rails will bear equally on the troughs and be true to grade surfaces. In order to deaden the sound due to the vibration of the metal structure under passing trains the troughs will be filled with cork, mineral wool or some other suitable material made into a concrete with Portland cement, and experiments will be made in order to ascertain the material best suited for this purpose. On the deck spans there will be gas pipe handrails on each side of the viaduct and secured to the ends of the solid floor. The top rail will be of 2-in. pipe and the lower one of 1¾-in. pipe, with malleable iron couplings and with expansion joints over each column. The posts will be of 2-in. diameter pipe screwed into cast iron foot plates secured to the floor by three ⅝-in. bolts.

The outer tracks will be for local traffic and the two middle tracks for through traffic. There will be a station for local traffic only at 110th St., consisting of side platforms carried on brackets riveted

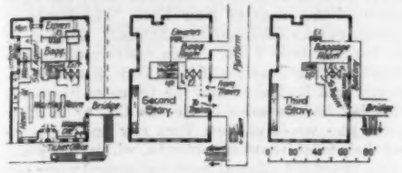



CROSS-SECTION OF STATION AT 125TH ST.




PLAN OF STATION ON PARK AVE. VIADUCT AT 125TH ST.

to the main plate girders. The platforms will have waiting-rooms, and iron umbrella roofs over the platforms and over the stairs to the street. At 125th St. there will be a larger station, with a brick building on the southeast corner of 126th St., and having facilities for handling baggage, as some of the




Floor Plans of 125th St. Station Building.

through main line trains will stop here to accommodate passengers from the Harlem district. The general arrangement of this station is shown by the accompanying drawings. From the first floor of the station building stairways lead to the platform, and there are four elevators, two for passengers and two for baggage. Passengers and baggage for southbound local trains will be landed at the platform level. Passengers and baggage for the other tracks will be landed at the level of the overhead bridge, which has stairways and baggage elevators to the other three platforms. Exit stairways to 124th, 125th and 126th Sts. are provided for both local platforms, and will have turnstiles at the bottom to prevent access to the platforms from the street, and the only entrance will be through the main building. As the increase in local traffic is likely to require separate ticket offices to avoid the distance to the main station and back over the bridge to the platform, provision has been made for the addition to the shelter houses on the local platform, with short steps from the first landing of the present stairs. The arrangement will be somewhat the same as at the stations on the New York elevated railways. The present Mott Haven station, at 138th St. will be moved back bodily about 22 ft. west of its present position, to make room for the two additional tracks and platforms and the general rearrangement of the station, which will be similar to that at 125th St. and will be for local and some main line trains.

The Harlem River drawbridge will be a four-track structure 389 ft. long, with a central pivot pier and two openings of 100 ft. wide in the clear at right angles to current. It will be operated by steam, the plant being arranged in a house over the trusses. On the south side the steel viaduct will come up to the draw abutment, but on the north side there will be two truss approach spans. During the construction of this bridge the traffic will be carried over a substantial double-track timber trestle, now nearly completed. The temporary draw will be a double-track plate girder vertical lift span with one leaf of 106 ft. length, turning on a horizontal hinge, and fitted with compensating counterweights which adjust themselves to the varying leverage of the draw as it swings up and down.

## RAILWAY IMPROVEMENTS FOR THE WORLD'S COLUMBIAN EXPOSITION TRAFFIC.—II.

The probable increase of traffic, due to the World's Columbian Exposition, has led many of the railways to carry out improvements and make additions to their equipment in order to enable them to satisfactorily handle the traffic, while other railways have made similar improvements and additions which were beginning to be necessary but which might otherwise have been postponed. In a former article, in our issue of May 4, these conditions were referred to, and particulars were given of the work being done by some of the roads, and we present this week the particulars of other roads, for which we are largely indebted to the officers mentioned:

Canadian Pacific Railway.—The line from Montreal to Windsor is single-track, except between Montreal and Montreal Junction, 4.7 miles, where it is double-track. From Windsor the trains are ferried across to Detroit and run thence over the new Detroit extension of the Wabash R. R. into Chicago. While the road has been making extensive improvements on its line between Montreal and Windsor, they have not been made specially on account of the Exposition traffic. These improvements have consisted in the replacing of 60-lb. steel rails with the company's standard 72-lb. rails (illustrated in the article on "Canadian Railways" in our issue of Jan. 19), increased siding and yard accommodation, ballasting and new stations at some of the principal points. It is proposed to provide an interlocking plant at two or three of the railway grade crossings between Montreal and Toronto. West of Toronto most of the railway grade crossings and junctions are already interlocked. As to equipment, the company's shops have turned out quite a number of new locomotives during the past year, as well as a number of tourist and colonist cars and sleepers, but these were not built entirely on account of the Exposition business, as some, if not all, of them are required for the constantly increasing traffic of the road.

It is expected that this line will be patronized extensively by tourists from Great Britain and the continent, as a large proportion of this class of travel, particularly tourists from Great Britain, usually travels one way through Canada.

Reduced season and monthly rates have been arranged in connection with the Exposition, and special excursion trains will be run when warranted by the traffic offering. Regular trains run into the Dearborn St. station at Chicago (over the Wabash R. R.), but arrangements are being made to run trains direct into the terminal station in the Exposition grounds when required. The timetable which went into effect May 15 shows two daily trains from Montreal to Chicago, leaving at 8:25 a. m. and 9 p. m. and arriving at Chicago the following day at 10:10 a. m. and 10:15 p. m., respectively. The eastbound through trains leave Chicago at 2:30 p. m. and 10:30 p. m. and arrive at Montreal at 7:20 p. m. the next day and 7:40 a. m. the second day, respectively. The distance is 853 miles, of which 556 miles are between Montreal and Windsor. The through return fare at present between Montreal and Chicago is $28.80.

The company's exhibit at the Exposition consists of a complete standard passenger train, two fine models of the royal mail steamers running between Vancouver, Yokohama and Hong Kong, and a number of oil paintings of the scenery along the Canadian Pacific Ry. The exhibition train was built entirely at the company's shops at Montreal, and the cars have vestibuled connections throughout, and are fitted with steam heating plant. The train consists of an engine, tender, baggage car, second-class car, first-class car, dining car and sleeping car, and measures 400 ft. in length over all, 10 ft. 3½ ins. in width and 14 ft. 8 ins. in height. The engine is of the ten-wheel type, with cylinders 19×24 ins., driving wheels 5 ft. 9 ins. diameter, and weighs 213,000 lbs. in working order; it can haul a train of ten cars, or 420 gross tons, at a speed of 60 miles an hour. The tender is carried on two four-wheel trucks, and has a tank capacity of 3,000 gallons. The baggage car is 63 ft. 8 ins. long, on six-wheel trucks, and weighs 59,600 lbs. The second-class car is carried by four-wheel trucks, is 64 ft. 4 ins. long, seats 64 passengers, and weighs 65,300 lbs.; it is upholstered in leather, has a smoking compartment, lavatory and closets, and is converted into a sleeping car at night. The first-class car is 64 ft. 4 ins. long, carried on four-wheel trucks, seats 56 passengers and weighs 65,300 lbs.; the saloon is finished in white mahogany and copper-red plush, and the smoking-room in old oak and olive corduroy; Forney seats are used, and there are separate lavatories for men and women. The dining car is 70 ft. 10 ins. long, on six-wheel trucks, accommodates 30 passengers and weighs 85,000 lbs.; it is finished in white mahogany and yellow-brown leather. The sleeping car is 77 ft. 2 ins. long, on six-wheel trucks, seats 44 passengers and weighs 94,000 lbs.; it has two state-rooms, bath-room, smoking-room, lavatories, etc., and is finished in white mahogany and sage-green plush. The exterior finish of the cars is of Honduras mahogany, and the interiors are from special designs by Mr. E. Colonna, architect, of Montreal. The whole train is completely fitted and equipped, very handsomely finished, and in charge of conductors and trainmen to show visitors through the cars. We expect to give further particulars of this elaborate railway exhibit in a later issue, in connection with a description of the railway exhibits of the Exposition. We are indebted to Mr. W. C. Van Horne, President; Mr. Thomas Tait, Assistant General Manager, and Mr. D. McNicoll, General Passenger Agent, for information from which the above particulars of the road and its exhibit have been compiled.

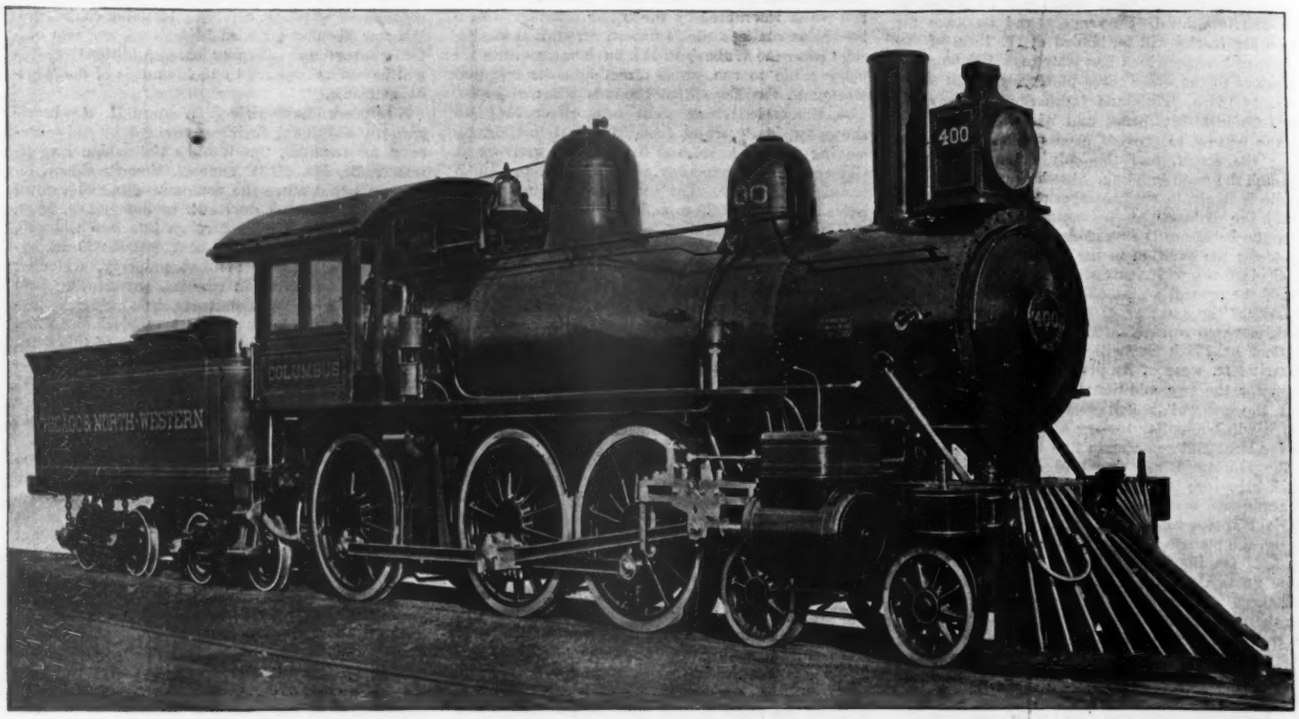
Wabash R. R.—This road has done some work in double-tracking and putting its roadbed in condition, and a double-track will probably be laid between Forest Hill and Clarkdale Junction. Mr. Charles M. Hays, General Manager, informs us that during last autumn, 37 locomotives and 25 passenger cars were added to the equipment, and that while the additional equipment was not bought specially on account of the Exposition traffic, that matter undoubtedly had a very important bearing on the decision reached to provide such additional equipment. The Wabash R. R. runs into the Dearborn St. terminal station, Chicago, as stated in former notes in our issue of May 4. The trains will not run to the Exposition grounds, nor has the company made any exhibit at the Exposition. Between Chicago and St. Louis there are two regular through daily express trains each way, a day train and a night train. The day train has smoking car, two reclining-chair cars (no extra charge for seats), a buffet parlor car and a dining car. The night train is vestibuled throughout, and consists of smoking car, two reclining-chair cars, Wagner sleeping car with 14 sections, and two buffet compartment sleeping cars. Additional trains will be run as required by the demands of the Exposition traffic.

New York, Lake Erie & Western R. R.—In regard to additional facilities secured by this company for handling the World's Columbian Exposition traffic, Mr. E. B. Thomas, Vice-President, informs us that since the company obtained control of the Chicago & Erie R. R. in September, 1890, which gives the Erie a through line into Chicago, the company has spent about $2,000,000 in improving the roadbed of that property, widening embankments, filling in trestles, substituting iron and stone for wooden culverts, iron bridging, laying 80-lb. rails, side tracks, stations, block signaling, ballast, shops and equipment; but none of this work has been done with special reference to the World's Columbian Exposition. The company expects, of course, to reap a benefit from the expenditure during the Exposition traffic, but the work would have been done if there had been no Exposition.

There will be three daily through trains between New York and Chicago over the main line, and one via Buffalo and the Grand Trunk Ry. In addition to the through trains from New York, excursion trains will also be run from all places on the road, but the greatest preparation for the excursion business has been made for those 400 to 500 miles distant from Chicago. These are in most favor because they permit of day runs in ordinary cars, and two to three times the number of people can be carried comfortably in a day car as compared with a Pullman sleeping car. The trains will not run into the Exposition grounds. The company can give no estimate of the local and through traffic. The company has purchased 43 new passenger cars, and 50 passenger locomotives, requiring a corresponding expenditure. The entire line was equipped with the block signal system by May 1. Particulars of the arrangements of the Dearborn St. terminal station, Chicago (owned by the Chicago & Western Indiana R. R.), were given in our issue of May 4. This railway will make no exhibit, but in the exhibit of the Baldwin Locomotive Works will be a decapod engine of the New York, Lake Erie & Western standard, which will become the property of this road at the close of the Exposition. As has already been stated, it would hardly be correct to say that the expenditures and improvements have been made on account of the Exposition. The additional facilities would have been secured in any event, and are not more than are necessary to enable the road to properly and safely take care of its regular business.

Lake Shore & Michigan Southern.—This road is now practically double-track throughout, and is in condition to handle considerable traffic. The electric block signal system of the Union Switch & Signal Co. is to be established between Toledo and Buffalo, 296 miles. Mr. John Newell, the president, informs us that 10 locomotives and 50 passenger cars have been added to the equipment in view of the expected demands for the Exposition traffic, which it is expected to carry at high speeds. Special attention will be paid to local and excursion traffic, and many of the trains

will run into the Exposition terminal station. Some of these will be through trains from Buffalo, but most of them will be from nearer places. According to a preliminary announcement issued by the passenger department, the New York & Chicago limited express was discontinued May 14, and four through trains per day between New York and Chicago (two each way), and two between Pittsburg and Chicago, were added to the list. One of these new trains is the "Exposition Flyer," leaving New York at 3 p. m. (eastern time) and arriving at Chicago 10 a. m. (central time); while the corresponding eastbound "Flyer" leaves Chicago at 2 p. m. (central time) and arrives at New York 11 a. m. (eastern time). These trains are to consist of two sleeping cars and one buffet smoking and library car, with a dining car between Toledo and Chicago in both directions. The other through trains will leave New York and Chicago at 12 (noon) and 12:30 p. m. and arrive at Chicago and New York at 1 p. m. and 3:45 p. m., respectively. Other changes will probably be made in order to meet the demands as the traffic develops.




TEN-WHEEL PASSENGER ENGINE, CHICAGO & NORTHWESTERN RY.; Schenectady Locomotive Works, Builders.

Mr. A. J. Smith, General Passenger Agent, informs us that in addition to these through trains there will probably be excursion trains, one or two from Buffalo, one from Cleveland, and two from Toledo (one of these over the old road, and one over the Air Line), and also special trains starting from Coldwater and from Kendallville. The arrangements for the train service on account of the Exposition have not yet been fully settled. The road will have an exhibit at the Exposition.

The officers of the Lake Shore & Michigan Southern Ry. and the Chicago, Rock Island & Pacific Ry. arranged for the reconstruction of their terminal station on Van Buren St., Chicago, which is owned jointly by the two roads. The station is an old structure, and it was at first proposed to entirely rearrange it, but this was given up. Two additional tracks will be laid in the station and several other changes made, which will materially increase its facilities. Changes will also be made in the arrangement of the offices.

Chicago, Rock Island & Pacific Ry.—Mr. E. St. John, General Manager, informs us that it would be a difficult matter to give in detail the amount of money which has been expended as the result of the location of the World's Columbian Exposition at Chicago, and no effort has been made to separate the items so that this could be determined to a certainty. While the railway fraternity might attach little importance to the details as to what this company has accomplished in the way of making provision for handling the crowds during the period of the Exposition, it may be stated that the company has been to a very large expense in the matter of additional equipment of engines and cars, and that it believes itself able to care for the business that will be offered to it. Mr. St. John says that "if at the end of the Exposition we shall have accomplished this the public will appreciate the fact, and if no serious difficulty has been experienced by any of our Chicago lines in the conduct of this business it will be a matter of congratulation for them and for us." Additional station accommodations have been provided for, as noted in the previous statement referring to the Lake Shore & Michigan Southern. So far as double-tracks are concerned, the road is a double-track line from Chicago to the Mississippi River, and, in fact, as far as Des Moines, because it has two lines under its control accessible to that point, one by the way of Iowa City and Grinnell and the other by way of Washington, Oskaloosa and Knoxville Junction. The removal of the freight yards to Blue Island is of very great benefit in the handling of the trains. The regular trains stop at Englewood, which is convenient for local traffic to the Exposition, and excursion trains will be run into the Exposition terminal station, probably using the Baltimore & Ohio R. R. tracks from South Chicago. It owns its road to that point, the branch leaving the main track at South Englewood.

## BOUCICAULT BRIDGE, OMISSION.

The accompanying illustration was omitted by mistake from the article on the Boucicault Bridge

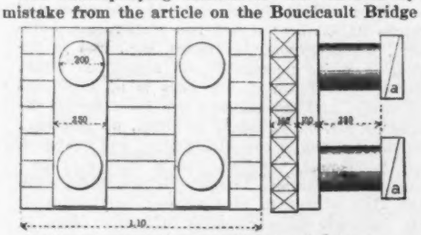



Fig. 11. Arch Supports, Boucicault Bridge.

in our last issue. For the details of its construction and use see description of Fig. 11, on page 473.

## THE OLD METROPOLITAN SANITARY DISTRICT OF NEW YORK, 1866 TO 1870.

In connection with the discussions favoring a Greater New York, it is interesting to note that as far back as 1866 there was created by the legislature of the state of New York "The Board of Health of the Metropolitan Sanitary District of the State of New York." This sanitary district included the four counties of New York, Kings, Westchester and Richmond and the towns of Newtown, Flushing and Jamaica in Queens Co., or in other words the whole of New York city and Brooklyn and their most important suburbs. within this state.

This board did efficient work for several years and published annual reports possessing both interest and value at the present time. Mr. Wm. E. Worthen, M. Am. Soc. C. E., was engineer of the board and as such worked out quite an elaborate scheme for a bulkhead system combining a marginal intercepting sewer, subway for gas and water mains and a belt line of four-track elevated railway, for freight and passenger service, with branches to the several piers. This scheme is outlined and illustrated in the report for the year 1868, p. 162. Mr. Worthen also reported on an elaborate system of salt water supply for street and sewer flushing, the estimated cost of which was about $4,000,000. This scheme may be found in the report for 1869, pp. 568-72. Prof. C. F. Chandler served as chemist to the board and made some analyses of Croton water as early as 1867. Analyses of water from Jamaica Pond, of the Brooklyn water supply, made by Prof. A. K. Eaton in 1860 are also included in the report for 1869. In the report of the board for 1869 may be found a short report, with two illustrations, by Wm. B. Lewis, M. D., on the "Microscopical Examination of the Croton and Ridgewood Waters,' the latter referring to the city of Brooklyn. The "gas nuisance" also received attention from the board and its history is given by Professor Chandler in the report for 1869, together with a description of processes of purification and testimony on the subject.

The board made careful studies of cholera, which was epidemic during its existence, and took vigorous action for its suppression. The same was true of Texas cattle fever, the report for 1869 containing the results of much original investigation, accompanied by colored lithographs.

The general health and mortality of the whole metropolitan district were carefully and sys-

tematically studied by the board and many nuisances abated. Maps were made and published showing the relative density of the population in different sections of the city and the localities in which cholera and diarrhoeal diseases were epidemic. Instructive mortality diagrams were prepared and published. Suburban and urban localities with bad surface drainage were studied, the former more especially in the fourth report. In short the board showed a wonderful activity and did so much good work that, so far as can be judged from the reports alone, it seems a pity that the board and its work was not continued, instead of having been succeeded by local boards, some of which have done little or no work since.

By the adoption of a new city charter in 1870 New York city was exempted from the provisions of the act establishing the Metropolitan Sanitary District and the Board of Health of the Health Department of the city of New York was organized. In 1873 the Board was reorganized under the new city charter of that year, since which time there has been no change in its form.

Mr. Emmons Clark has been secretary of the various boards from 1866 to the present time.

## WORLD'S COLUMBIAN EXPOSITION.—XI.

### Exhibit of the Schenectady Locomotive Works.

The exhibit of locomotives at the Exposition is one of unusual interest, including a number of engines of standard American types, and nearly a dozen foreign engines (the latter including the London & Northwestern Ry. three-cylinder compound and Mr. Winby's four-cylinder simple engine, described in our issues of March 23 and April 13). The Schenectady Locomotive Works, Schenectady, N. Y., exhibit four engines, two of which are illustrated herewith, and the accompanying table

LOCOMOTIVES OF THE SCHENECTADY LOCOMOTIVE WORKS, WORLD'S COLUMBIAN EXPOSITION.

| | Duluth & Iron Range R. R. | Chicago & Northwestern R. R. | Mohawk & Malone R. R. | Schenectady Loco. Works. |
|---|---|---|---|---|
| RUNNING GEAR. | Twelve-wheel freight. | Ten-wheel passenger. | Consolidation compound. | Six-wheel switching. |
| Number driving wheels | 8 | 6 | 8 | 6 |
| " truck " | 4 | 4 | 2 | |
| Driving wheels, diam. | 4 ft. 6 ins. | 5 ft. 7 ins. | 4 ft. 3 ins. | 4 ft. 3 ins. |
| Truck " " | 2 " 4 " | 2 " 9 " | 2 " 6 " | |
| Tender " " | 2 " 9 " | 2 " 9 " | 2 " 9 " | 2 ft. 6 ins. |
| Truck wheels, all spoke center, steel tire | Steel tire. | Washburn steel tire. | Krupp steel tire. | |
| Tender " all cast iron, chilled plate | Bass. | Barnum-Richardson | Rochester. | Thacher. |
| Engine truck, swing or rigid center | Swing center. | Rigid center. | Swing center. | |
| Journals, driving axles | 8½ ins. diam. × 9 ins. long. | 7½ ins. diam. × 8½ ins. long. | 8½ ins. diam. × 9 ins. long. | 7½ ins. diam. × 8½ ins. long. |
| " truck axles | 5 " " × 8 " " | 5 " " × 9 " " | 6 " " × 10 " " | |
| " tender axles | 4¾ " " × 7 " " | 4½ " " × 8 " " | 4½ " " × 8 " " | 3¾ " " × 7 " " |
| " crank pin, main pin, main rod | 6 " " × 6 " " | 6 " " × 6 " " | 6 " " × 6 " " | 4½ " " × 4½ " " |
| " " " side rod | 6½ " " × 5¼ " " | 6¼ " " × 5 " " | 6½ " " × 5¼ " " | 5 " " × 5 " " |
| " " interm. pin " " | 5½ " " × 4½ " " | | 5½ " " × 4½ " " | |
| " " front pin, " " | 5½ " " × 3¾ " " | 5 " " × 2⅞ " " | 5 " " × 3¾ " " | 4½ " " × 3½ " " |
| " " back pin, " " | 5 " " × 3¾ " " | 5 " " × 3⅝ " " | 5 " " × 3¾ " " | 4½ " " × 3½ " " |
| WHEEL BASE.—Driving | 15 ft. 6 ins. | 14 ft. 11 ins. | 14 ft. 0 in. | 11 ft. 0 ins. |
| Truck | 6 " 0 " | 5 " 8 " | | |
| Total engine | 25 " 4 " | 25 " 3 " | 21 ft. 7 ins. | 11 f., 0 in. |
| " tender | 11 " 8 " | 15 " 11½ " | 15 " 3½ " | 15 " 0½ " |
| " engine and tender | 51 " 7 " | 47 " 9½ " | 47 " 2½ " | 38 " 6 " |
| Center of truck pin to center of leading driver | 6 " 10 " | 13 " 5 " | 7 " 7 " | |
| Number and order of wheels having blind tires | Second and third pairs. | Front pair. | Second and third pair. | Middle pair. |
| Total length of engine and tender | 59 ft. 10⅝ ins. | 58 ft. 4⅜ ins. | 57 ft. 1⅝ ins. | 51 ft. 4⅞ ins. |
| WEIGHT in working order on drivers | 159,000 lbs. | 96,000 lbs. | 132,000 lbs. | 90,000 lbs. |
| On truck wheel | 30,000 " | 33,000 " | 17,000 " | |
| Engine, total | 169,000 " | 129,000 " | 149,000 " | 99,000 " |
| Tender, total | 73,185 " | 80,255 " | 84,355 " | 61,300 " |
| Engine and tender, loaded | 242,185 " | 209,255 " | 233,355 " | 160,300 " |
| Tender, empty | 31,000 " | 32,900 " | 35,000 " | 29,300 " |
| Of full coal capacity | | 46,900 " | | |
| Of full water capacity of tank | | 76,255 " | | |
| CYLINDERS.—h. p. | (Two) 22 × 26 ins. | (Two) 19 × 24 ins. | (One) 22 × 26 ins. | (Two) 18 × 24 ins. |
| " l. p. | | | (One) 32 × 26 ins. | |
| Distance center to center | 7 ft. 2 ins. | 7 ft. 0 in. | 7 ft. 2 ins. | 7 ft. 0 in. |
| " center to valve face | 18⅝ ins. vert., 3 ins. hor. | 18⅝ ins. vert., 2½ ins. hor. | 21¾ ins. vert., 3 ins. hor. | 16¼ ins. vert., 3½ ins. hor. |
| Piston, horizontal thickness | 5¼ ins. | 1¼ ins. | 4¾ and 5¾ ins. | 5¼ ins. |
| Piston packing | Cast iron rings. | Cast iron rings. | Cast iron rings. | Cast iron rings. |
| Piston rod, diameter | 4 ins. | 3½ ins. | 4 ins. | 3½ ins. |
| Piston rod packing, all metallic | Columbian. | Sullivan. | United States. | United States. |
| Form of crosshead and guides | Laird. | Laird. | Laird. | Laird. |
| Connecting rod, length between centers | 8 ft. 5¼ ins. | 9 ft. 5 ins. | 9 ft. ⅛ in. | 5 ft. 9 ins. |
| VALVE GEAR.—Type | Link. | Link. | Link. | Link. |
| Ports, steam | 18 × 1¼ ins. | 18 × 1¼ ins. | h.p., 19×2½ ins.; l. p., 21×2½ ins. | 16 × 1¼ ins. |
| " exhaust | 18 × 3 " | 18 × 2¾ " | h. p., 19×3 ins.; l. p., 21×3½ ins. | 16 × 2½ " |
| Bridges, width | 1¼ ins. | 1¼ ins. | 1¾ ins. | 1 in. |
| Slide valves, lap | O., ¾ in.; I., 1/32 in. | O., ¾ in.; I., 1/32 in. | O., ⅞ in.; I., 0 in. | O., ⅞ in.; I., 1/32 in. |
| " " maximum travel | 5½ ins. | 5½ ins. | 5¼ ins. | 5¼ ins. |
| " " lead in full stroke | ⅛ in. | ⅛ in. | ⅛ in. | ⅛ in. |
| Valve stem packing, all metallic | Columbian. | Sullivan. | United States. | United States. |
| BOILER.—Type | Straight. | Extended wagon top. | Wagon top. | Straight. |
| Diameter of first ring, outside | 6 ft. 0 in. | 5 ft. 0 in. | 5 ft. 2 ins. | 4 ft. 8 ins. |
| Thickness of barrel plates | ⅝ and 11/16 in. | 7/16 in. | ⅛, 7/16, and ⅝ in. | 1/2 in. |
| Thickness of smokebox tube plate | ⅞ in. | ⅛ in. | ⅛ in. | 1/2 " |
| Height from rail to center line | 8 ft. 2⅛ ins. | 7 ft. 10¼ ins. | 5 ft. 6 ins. | 7 ft. 0½ ins. |
| Length of smokebox | 3 " 0 " | 5 " 11 " | 3 " 4 " | 4 " 6 " |
| Working steam pressure | 180 lbs. | 170 lbs. | 180 lbs. | 150 lbs. |
| Maker of steel | Spang. | Wellman. | Worth. | Worth. |
| Seams, horizontal | Sext. riv., butt joints. | Sextuple riveted, butt joints | Sext. riv., butt joints. | Quadruple riveted, lap joints. |
| " circumferential | Double. | Double. | Double. | Double. |
| Throttle, all balanced valve | Double poppet. | Double poppet. | Double poppet. | Balanced. |
| Injectors | Two No. 10 monitors. | 1 No. 10 mon., 1 No. 9 Aw. | Two No. 10 monitors. | Two No. 8 monitors. |
| FIREBOX. | | | | |
| Length inside | 10 ft. 0⅛ ins. | 6 ft. 5½ ins. | 9 ft. 0⅝ ins. | 8 ft. 0⅜ ins. |
| Width inside | 3 " 5⅝ " | 2 " 9 " | 3 " 5⅝ " | 2 " 9⅝ " |
| Depth at front | 5 " 5⅜ " | 7 " 0 " | 5 " 2⅜ " | 4 " 11 " |
| Depth at back | 5 " 2¼ " | 7 " 0 " | 4 " 11⅜ " | 4 " 8 " |
| Thickness of side plates | 5/16 in. | ⅜ in. | ⅛ in. | ⅛ in. |
| " " back plates | 5/16 " | 3/8 " | 1/2 " | 1/2 " |
| " " crown sheet | ⅜ " | ⅜ " | ⅜ " | ⅜ " |
| " " tube sheet | 5/16 " | ⅛ " | ⅛ " | ⅛ " |
| Maker of steel | Spang. | Shoenberger. | Otis. | Otis. |
| Crown sheet staying | 7 × ¾ in. crown bars. | 1-in. radial stays. | 6 × ¾-in crown bars. | 5 × ¾-in. crown bars. |
| Grates | Rocking. | Rocking. | Rocking. | Rocking. |
| Ash pan | Hopper, with dump plates. | Plain. | Sectional. | Plain. |
| Grate area | 31.5 sq. ft. | 17.8 sq. ft. | 31.1 sq. ft. | 22.6 sq. ft. |
| Stayboits, diameter | ⅞ in. and 1 in. | ⅞ in. and 1 in. | ⅞ in. and 1 in. | ⅞ in. and 1 in |
| " pitch | About 3¾ ins. | About 3¾ ins. | About 3¾ ins. | About 3¾ ins. |
| Water space, width | Sides & b'ck 3½ ins., front 4 ins. | S. and b., 3½ ins.; front, 4 ins. | S. and b., 3 ins.; front, 4 ins. | S. and b., 3 ins.; front, 4 ins. |
| TUBES.—Material | Charcoal iron. | Charcoal iron. | Charcoal iron. | Charcoal iron. |
| Number | 280 | 268 | 301 | 200 |
| Pitch | 3 ins. | 2¾ ins. | 2¾ ins | 2½ ins. |
| Diameter outside | 2¼ " | 2 " | 2 " | 2 " |
| Thickness | 12 W. G. | 11 W. G. | 11 W. G. | 13 W. G. |
| Length over tube plate | 13 ft. 6 ins. | 12 ft. 6 ins. | 12 ft. 0 in. | 11 ft. 0 in. |
| Total fire area of tube openings | 6.28 sq. ft. | 4.47 sq. ft. | 5.02 sq. ft. | 3.34 sq. ft. |
| HEATING SURFACE.—Tubes, exterior | 2,212.6 " | 1,642.3 " | 1,878.0 " | 1,147.5 " |
| Firebox | 189.7 " | 161.0 " | 162.2 " | 131.2 " |
| Total with exterior tube area | 2,402.3 " | 1,806.3 " | 2,046.2 " | 1,278.7 " |
| MISCELLANEOUS. | | | | |
| Exhaust nozzle | Single. | Double. | Single. | Double. |
| " " diameter | 5¼, 5½ and 5⅝ ins. | 3¼, 3½ and 3⅝ ins. | 5, 5¼ and 5½ ins. | 2¾, 3½ and 3⅝ ins. |
| Smokestack, diameter inside | 16 ins. top and bottom. | 16 ins. near bottom. | 14 ins. near bottom. | 16 ins. near bottom, |
| " " height from rail to top | 14 ft. 10 ins. | 14 ft. 10 ins. | 14 ft. 5 ins. | 13 ft. 6½ ins. |
| Capacity of tank | 3,500 gallons. | 4,000 gallons. | 4,000 gallons. | 3,000 gallons. |
| " " coal space | 13,000 lbs. | 14,000 lbs. | 16,000 lbs. | 7,000 lbs. |
| Tender frame | 8-in. channel iron. | 6½ × 4 × ⅜ in. angle iron; Schenectady Locomotive Works standard. | | |
| Tender truck, all 4 wheel, center bearing,, with additional side bearings on back truck | Wood bolster. | Channel iron; Schenectady Locomotive Works standard. | | |
| Brake fittings, driving wheels | New York. | Westinghouse. | American outside equalized on all drivers, operated by air. Westinghouse. | Westinghouse. |
| " " tender and train | | | | |

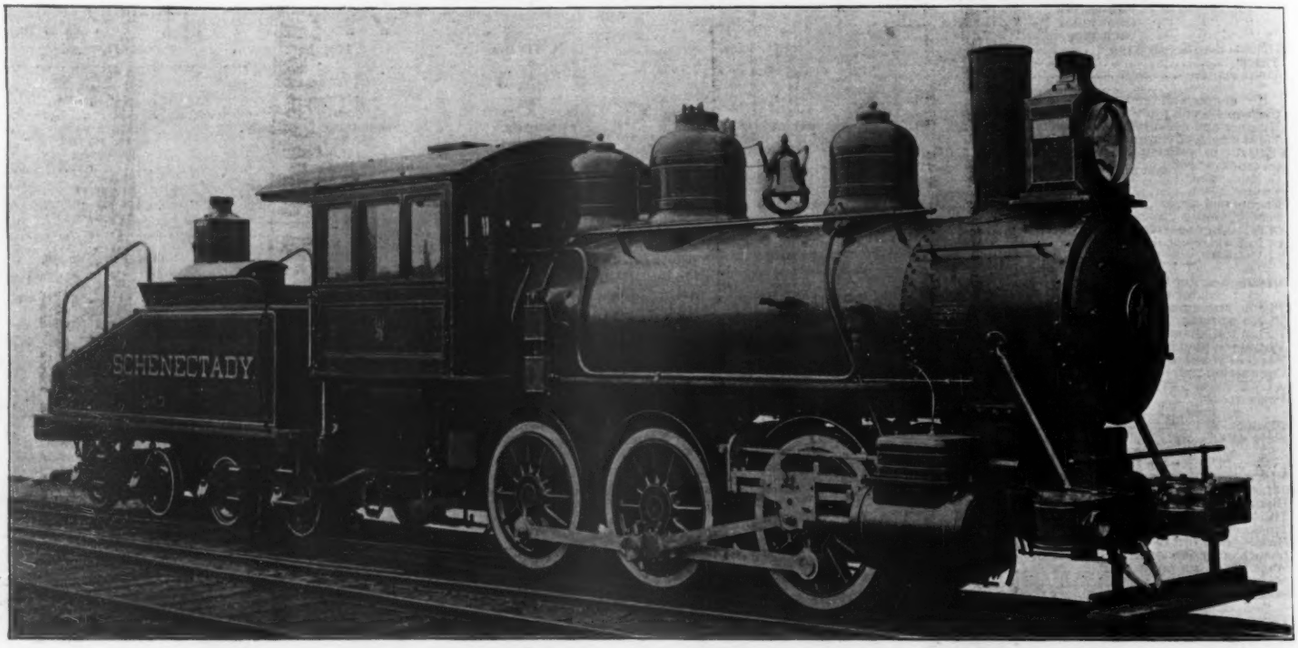
* Chicago & Northwestern; push down cylinders for driver brakes.

gives the full dimensions and particulars of the four engines. The largest is an immense engine of the twelve-wheel or mastodon type for freight service on the Duluth & Iron Range R. R., which weighs 169,000 lbs. (139,000 lbs. on the eight driving wheels), and is somewhat similar to the twelve-wheel engines of the Iron Range & Huron Bay R. R., and those built by the same works for the Southern Pacific Ry. (Eng. News, April 28 and July 7, 1892). Next to this in point of size is a two-cylinder compound consolidation engine for the Mohawk & Malone R. R., which weighs 169,000 lbs., with 132,000 lbs. on the eight driving wheels. This is very similar (except for the addition of the extra pair of driving wheels) to the mogul engine of the Adirondack & St. Lawrence R. R., illustrated in our issue of April 28, 1892. The Schenectady Locomotive Works make a specialty of two-cylinder compound engines, and have built about 75, for different classes of service. In these engines an intercepting valve is used which was designed by Mr. A. J. Pitkin, Superintendent of the works, and illustrated and described in our issue of April 20, 1893. The next heaviest engine is a ten-wheel passenger engine for the Chicago & Northwestern R. R., weighing 129,000 lbs., with 96,000 lbs. on the six driving wheels. This engine we illustrate as an example of modern American practice in locomotives for fast heavy traffic, especially where numerous stops require a large reserve of power in raising a heavy train to high speed. The fourth engine is a six-wheel switching engine of ordinary design, and represents a type of engine very extensively used.

These four engines indicate not only the modern tendency to high power engines for very heavy trains, but also the tendency to extreme simplicity in design. The absence of moldings and decorative work, and of the coloring and intricate striping which are features of English locomotives, is very noticeable, and the plain pipe smokestacks, Russia iron sheathing and black paint with little lettering or striping, add to the grim and powerful, but by no means unpleasing, appearance of the engines. We are indebted to Mr. A. J. Pitkin, Superintendent of the Schenectady Locomotive Works, for photographs and dimensions of these engines.

### Deane Pump Exhibits.

The Deane Steam Pump Co., of Holyoke, Mass., has 17 of its machines on exhibition, and all but one are in operation in the several departments. One of the machines, forming a part of the United States Patent Office exhibit, is a section of the company's boiler feed pump, showing the construction of the interior of the pump and the working of the Deane patent valve motion. There are two duplex pumps, each with 7½-in. steam cylinders, 4½-in. water plungers and 10-in. stroke, in the main boiler-room, furnishing feed water for the boilers. In the Machinery Building there are two Deane air and circulating pumps, with steam cylinder, vacuum cylinder and water cylinder, all 16 ins. diameter and 16-in. stroke, each in connection with a Wainwright surface condenser, on a 21½ and 37×22 Westinghouse compound engine. In the Western Dummy Ry. Co.'s power-house there is a Deane patent independent condensing apparatus on a 13 and 23×22 McIntosh & Seymour compound engine. The condensing apparatus consists of a vacuum pump with 8-in. cylinder, 12-in. vacuum cylinder and 12-in. stroke, with a jet condenser. All of the pumping machinery in the Ice and Cold Storage Building is furnished by this company. There are seven duplex pumps, pumping brine and water, of the following dimensions: Four with 6-in. steam cylinders, 5¾-in. water plungers and 6-in. stroke; two with 10-in. steam cylinders, 10¼-in. water plungers and 10-in. stroke; one with 9-in. steam cylinders, 8½-in. water plungers and 10-in. stroke. There are two 10×6×10 duplex and two 7½×4×10 duplex double plunger pumps feeding boilers. The double plunger pumps are furnishing water to boilers which carry a steam pressure of 300 lbs. The headquarters of the company are in the Ice Building, and Mr. F. S. Scott is the manager in charge of the pumps.




SIX-WHEEL SWITCHING ENGINE; Schenectady Locomotive Works, Builders.

## RUN-OFF FROM VARIOUS DRAINAGE BASINS IN THE UNITED STATES.

By F. H. Newell.

In many computations preliminary to engineering construction it is necessary to know the probable "run-off" or amount of water discharged from any given watershed. For this purpose it has been customary to bring together all of the data of rainfall available, and next to make assumptions more or less arbitrary concerning the proportion of this which will reach a given point on the stream under consideration. This is often the best method which can be employed, especially in the case of small basins where the amount and distribution of the rainfall have been studied for years, but in large drainage basins embracing areas in which the precipitation has been measured at only a few points, perhaps for a short time at towns in a valley, the assumptions involved in estimating the probable rainfall and the relation of this to the discharge are so great that the resulting figures amount to little more than guesses.

The above statement is exemplified by an instance in which certain published figures of mean discharge of a stream were questioned as being entirely too low. It was asserted that there must be some error in the data, since the application of all well-known formulas to the measured rainfall gave results ten times as great. The facts in the case were, however, that the published figures of mean discharge were the result of nearly 100 gagings, and of tri-daily observation of river height. This may be taken simply as illustrating the well-known fact that there are persons, and perhaps a large body of men, presumably capable of making estimates, but who place entirely too much faith in printed formulas and deductions.

In the arid regions of the West, especially, the measurements of rainfall are at points so widely separated and are so fragmentary that they afford little clue to the total precipitation over large basins. Results of such observations at some point in an arid valley can have little value in discussions of water supply from the high mountains adjacent. On the other hand, observations at some mining camp may give a fictitious value to the water resources over the broad plateaus surrounding it.

There seems to be necessity of emphasizing the importance of bringing together and carefully consulting the results of actual stream measurements. It would sometimes appear from reading discussions that the best way of obtaining the discharge of a stream was by studying rainfall and by employing the resulting data. On the contrary, would not the same amount of energy and time spent in actual gaging or even in studying the fluctuations of similar streams often yield far better results? As a matter of fact, except, perhaps, in very small basins, it is exceedingly difficult to correlate the discharge of a stream, even through a series of years, with the quantity of rainfall as measured in the ordinary gage.

To state the matter in another way, there are two methods of obtaining estimates of probable run-off, the first that in which the precipitation data are made the basis, the second in which measurements of discharge of other streams are the foundation. The careful engineer, of course, will employ both methods as far as practicable, checking one result against another, but the tendency seems to be, at least among the less skilled, to rely almost exclusively on the first to the neglect of the second. Of the two it may be asked whether the second is not to be preferred as the more re-

liable? The answer must be that it is, provided that there is at hand a fair amount of information.

In the following table an attempt has been made to bring together, for the convenience of those interested, a few of the more important facts now known concerning the run-off of various streams in different parts of the United States. These, as will be noted, are of unequal value, some being the results of several years' work, others of far shorter periods. In glancing over the table, which is arranged in a general way, according to geographic position, it will be seen that the Eastern streams have a far higher run-off per square mile of catchment area than do those of the West, especially in the matter of maximum discharge. The mean run-off per square mile does not, however, at first glance appear to be as much higher as might be anticipated. The table also illustrates the generally accepted fact that the run-off from large catchment areas is less per square mile drained than from small.

The greatest discharge from a small drainage area, as far as the figures at hand show, was in the case of South Fork Creek, Pennsylvania, in 1889, reaching, according to the committee of engineers, the rate of over 215 sec.-ft. per square mile, the watershed being somewhat under 49 square miles. This, of course, is an extreme case. In most of the instances given in the table the maximum would doubtless be increased and the minimum decreased were the observations continued for longer periods. The mean discharge of rivers of small size in the eastern part of the United States would appear to be, according to this table, from about 1.5 sec.-ft. per square mile to 2 sec.-ft. per square mile, while in the Rocky Mountain region the range may be said to be from 1 sec.-ft. per square mile downward. The streams in this latter region which discharge throughout the year an average of more than 1 sec.-ft. per square mile either flow from very small catchment areas or have some peculiar feature which needs explanation.

[Run-off from Various Drainage Basins in the United States.

| River. | Drainage area square miles. | Period. | Second-feet per square mile. Max | Min. | Mn. |
|---|---|---|---|---|---|
| Merrimac, Mass | 4,599 | ..... | 20.87 | .30 | .. |
| Concord, Mass | 361 | ..... | 12.30 | .17 | .. |
| Sudbury, Mass | 76 | 1875-90 | 44.26 | .67 | 1.67 |
| Connecticut | 10,234 | 1871-85a | 20.90 | .50 | 1.86 |
| Croton, N. Y | 333 | 1858-81 | 75.22 | .21 | 1.65 |
| Oswego, N. Y | 5,013 | ..... | .82 | .23 | .. |
| South Fork Creek, Pa | 49 | 1889 | 215.14 | .. | .. |
| Tobickon, Pa | 102 | 1884-91 | 110.6 | .03 | 2.34 |
| Neshaminy, Pa | 139 | 1885-91 | 78.3 | .03 | 1.85 |
| Perkiomen, Pa | 152 | 1885-91 | 69.2 | .14 | 1.90 |
| Raritan, N. J | 879 | 1890 | 27.0 | .48 | 1.72 |
| Passaic, N. J | 773 | 1888-90 | 24.8 | .43 | 2.58 |
| Paulinskill, N. J | 175 | 1890 | 16.5 | .17 | 1.69 |
| Ramapo, N. J | 160 | 1890 | 28.5 | .25 | 1.73 |
| Musconetcong, N. J | 156 | 1889-91 | 20.3 | .39 | 1.19 |
| Potomac | 11,043 | 1886-91 | 42.6 | .17 | 1.85 |
| Savannah | 7,294 | 1884-91 | 41.2 | .27 | 1.64 |
| Kanawha | 8,900 | ..... | 13.3 | .12 | .. |
| Onio | 200,500 | 1882 | 6.17 | .27 | 2.10 |
| Mississippi, upper, Grafton, Ill | 164,534 | 1882 | 2.38 | .19 | .90 |
| Mississippi, lower, Carrollton, La | 1,214,000 | 1882 | 1.00b | .21 | .50 |
| Missouri, in Montana | 17,615 | 1890-91 | 1.63 | .10 | .27 |
| Missouri, at St. Charles | 525,500 | 1879-90 | .71 | .05 | .18c |
| West Gallatin, Mont | 850 | 1890-92 | 8.09 | .38 | 1.13 |
| Madison, Mont | 2,085 | 1890-92 | 3.08 | .51 | .93 |
| Yellowstone, Mont | 2,760 | 1890-92 | 5.74 | .11 | 1.49 |
| Cache la Poudre, Colo | 1,060 | 1889-91 | 5.28 | .03 | .82 |
| Arkansas, Colo | 3,000 | 1888-92 | 1.55 | .05 | .27 |
| Rio Grande, at Del Norte, Colo | 1,400 | 1890-92 | 4.24 | .14 | .80 |
| Rio Grande, at Embudo, N. M | 7,000 | 1889-92 | 1.22 | .02 | .20 |
| Rio Grande, at El Paso, Tex | 30,000 | 1890-92 | .55 | .00 | .06 |
| Gila, Ariz | 13,750 | 1890 | .46 | .00 | .04 |
| Salt, Ariz | 12 260 | 1888-91a | 24.5 | .03 | .31 |
| Truckee, Nev | 1,519 | 1890-91 | 4.95 | .24 | .95 |
| East Carson, Nev | 414 | 1890-92 | 10.26 | .70 | 1.78 |
| West Carson, Nev | 70 | 1890-91 | 18.34 | .50 | 2.39 |
| Bear, Battle Creek, Idaho | 4,500 | 1890-92 | 1.33 | .06 | .33 |
| Bear, Collinston, Utah | 6,000 | 1890-92 | 1.37 | .08 | .42 |
| Ogden, Utah | 360 | 1890 | 6.06 | .11 | 1.84 |
| Weber, Utah | 1,630 | 1890-92 | 3.60 | .06 | .60 |
| Provo, Utah | 640 | 1890-92 | 3.53 | .22 | .77 |
| Spanish Fork, Utah | 670 | 1890 | 1.55 | .07 | .26 |
| Sevier, Utah | 5,545 | 1890-92 | .42 | .01 | .09 |
| Falls, Idaho | 534 | 1890-91 | 7.46 | .76 | 1.65 |
| Teton, Idaho | 967 | 1890-92 | 5.45 | .41 | 1.13 |
| Snake, Idaho | 10,100 | 1890-92 | 5.41 | .20 | 1.02 |
| Owyhee, Ore | 9,875 | 18.0-92 | 1.82 | .01 | .21 |
| Malheur, Ore | 9,900 | 1890-91 | .45 | .00 | .05 |
| Weiser, Idaho | 1,670 | 1890 | 6.73 | .05 | .73 |

*a* Record broken. *b* For 1890. *c* Monthly means.

The above table has been obtained from compilation of data contained in the volume upon water power published as part of the Tenth Census of the United States, also from the Transactions of the American Society of Civil Engineers, and from other publications. The data concerning the New Jersey streams can be found in the annual reports of the state geologist of New Jersey, in the papers upon water supply prepared by Mr. C. C. Vermeule, C. E., and those concerning Western rivers in the reports of the United States Geological Survey in discussions connected with the subject of irrigation.

Without entering into a discussion of the difference in character of these drainage basins, it is obvious that such differences have a great influence, the effects resulting from these being greater than those attributable to differences in rainfall alone.

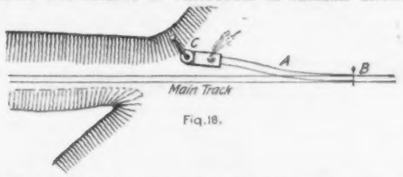


Fig. 18.

These matters cannot well be taken into account in formulas designed to give the run-off, and have, therefore, been generally neglected. The results of the stream measurements, as shown above, in their lack of uniformity or agreement, and by departing widely from what might have been expected, tend to show that little confidence can be placed upon usual computations, and that a large factor of safety must be used where lives or property depend upon structures designed to control or modify the water discharged from a given area.

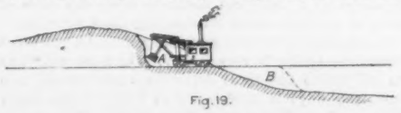


Fig. 19.

## STEAM SHOVELS AND STEAM SHOVEL WORK.*

By E. A. Hermann, M. Am. Soc. C. E.

Part II.—Steam Shovel Work.

(Continued from page 449.)

**Widening a Cut; Loading on the Main Track.**—The simplest and one of the most frequent cases for the application of a steam shovel is the widening of a single track railway cut. The manner of doing this is shown in Fig. 18. A switch, A B, is put in the main track just beyond the end of the cut and far enough away to permit the steam shovel (when standing on the side track) to clear cars on the main track. Cars are then placed opposite it on the main track and the machine is ready for excavation.

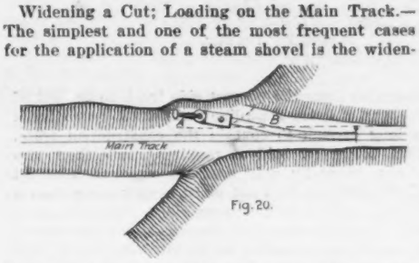


Fig. 20.

It very frequently happens that the end of the cut joins directly on an embankment, as shown in profile, Fig. 19. In cases of this kind it would be necessary to widen the embankment for the reception of the side track, near the end of the cut, if the machine were to begin work at that point, C, Fig. 18. This is very seldom done; the usual method is to remove the section, A, Figs. 19 and 20, to B by hand labor with wheelbarrows or with teams and scrapers. The excavated material is used to widen part of the embankment near the end of the cut for the reception of the side track. Section A is made barely long enough to provide a standing place for the steam shovel and clear cars on the main track; it is seldom over 50 ft. long, and averages about 30 ft. After placing the machine in this space it is ready for work. Strings of 10 to 20 cars are then drawn along the main track, and stopped opposite the machine for loading.

When the machine has reached the end of the switch, it advances on short sections of track, generally 4 ft. long, which are placed in front of it, and again taken from its rear when it has moved forward one section of track more than its own length. When no more cuts are to be made for still further widening, the switch is taken up again and the machine advances on its own track sections, Fig. 21. When other cuts are to follow,

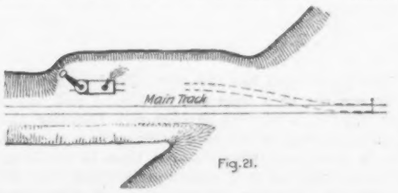


Fig. 21.

however, a loading track is needed for the next cut; the side track is then extended for this purpose at convenient intervals, generally about 300 ft. at a time, though often after each space of a rail length (usually 30 ft.) is clear. The latter is by far the best practice, as it permits the immediate withdrawal of the machine in case of a threatened cave-in, sidehill slip, or other unforeseen danger.

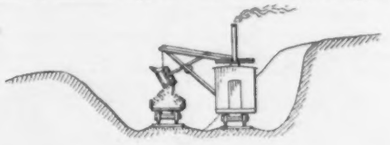


Fig. 22.

After all the cars have been loaded they are taken away for unloading. Sometimes the steam shovel is left idle until the train returns, which is a very wasteful method of working, even where the haul to the dump is short, half a mile to two miles. Two engines and crews should be furnished for hauls up to ten miles; three engines and crews, or more, for longer hauls, or where the traffic on the main line is very heavy, and delays to the work trains are frequent. The material is generally utilized in filling trestles, widening embankments for side tracks, double tracks, yards, etc., thereby making two improvements at the same time.

In widening a cut it is good policy to keep the grade of the pit from 1 to 2 ft. below the surface of the subgrade of the main track, as shown in Fig. 22, thereby providing for drainage of the ballast and also providing a receptacle for the spreading of loose material dropping off the cars and washing in from the surface of the cut; there is nearly always considerable of this loose material to roll or wash into the pit after the cut has been completed; and unless room is provided for it, the accumulation will soon reach the height of the track, washing mud on it, and choking the drainage, thus injuriously affecting the main track.

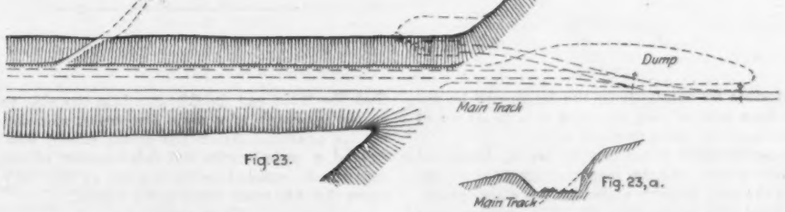


Fig. 23.



Fig. 23, a.

**Widening a Cut; Loading on a Side Track Grad-**

* Copyright, 1893.

ed by Hand or Steam.—The delays in loading on the main track of a railway in operation, due to the clearing of the track for all trains, vary from one to four hours per day of ten hours, and sometimes amount to as much as seven hours, depending upon the density of the traffic on the line. The first cut in a case such as the latter is therefore necessarily an expensive one, and where the traffic is so heavy it is often cheaper to make a narrow cut for the side track, on which the steam shovel is to load, either by wagons and wheel scrapers, Fig. 23, or by hand with wheelbarrows loading back on cars, Fig. 24.

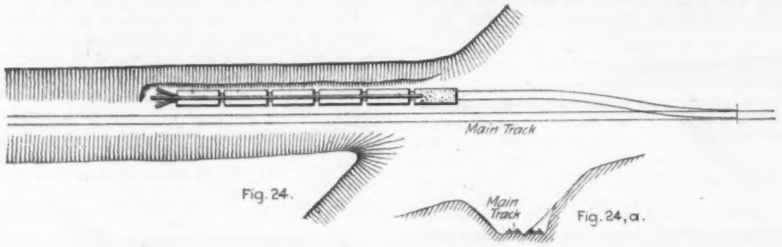


Fig. 24.



Fig. 24, a.

The latter plan has the great disadvantage that only one car at a time can be loaded and only a few men (six to ten) can be employed. Therefore this plan is never adopted where quick work is required, but is used only where ample time is available, and mostly as an early spring preliminary job, preparing the way for the operation of the steam shovel later in the season. From three to six flat or coal cars are used, enough to require a whole day for the gang of men employed to load; the material from the face of the excavation is loaded on wheelbarrows, and wheeled over the empty cars to the one farthest from the cut. This car is loaded first, then the one next to it, etc. At night the loaded cars are taken out of the switch by the first available freight train and hauled to the nearest yard or side track where widening of the embankment is wanted, or where the material can be otherwise used to advantage, and there unloaded by a small gang of men on the following day; the cars to be returned again the next night. Other empty cars are placed in the pit track for loading next day, by a train bound toward the pit the same night the loaded cars were taken out. The work can be carried on from either one or both ends of the cut. Coal cars should never be used if flats can possibly be obtained, as the latter can be unloaded by a gang of men one-third as large as would be necessary for unloading coal cars.

Sometimes small dump cars are used, drawn by horses or mules, and the material unloaded at the end of the cut, thereby widening the embankment for a long side track, Fig. 25. The narrow gage track, A, is laid over the ditch adjoining the main track; the material for any slight excavation that may be necessary for this track is shoveled on the slope of the cut, as at C on the cross section. The material is then loaded on small dump cars standing on track A, and unloaded at D. The cars are returned on track B. The cross-overs E and F, are taken up occasionally and relaid near the advancing ends of the cut and dump.

In short cuts the narrow excavation necessary for placing a side track in the cut for the steam shovel to load on is generally taken out by carts and dumped at the ends of the cut, widening the embankment for a long side track.

The plan of excavation with wagons or wheel scrapers for this side track, shown in Fig. 23, is adopted where the traffic is too heavy to permit loading on the main track; when the side track is wanted at the earliest possible time; and in cuts not over 40 ft. deep. The material is dumped at the ends of the cut until the haul becomes too long, then it is taken to the top of the cut over sidehill driveways excavated for the purpose, and unloaded at a sufficient distance from the edge of the new cut to prevent its washing back by rains.

These expedients are necessary only on railways where the traffic is very heavy. On most railways (on all where the total delay does not exceed five hours per day) it is cheaper to load on the main track until the first cut has been made. This necessarily involves the delay due to running to and returning from the nearest side track to get out of the way of every main line train, until the pit track is long enough to contain the construction train. This, however, seldom requires more than two weeks, generally only one; the excavation of all of the first cut does not often occupy more than a month, and is only a very short time compared with the whole length of time that the steam shovel is usually in operation on all but very small jobs.

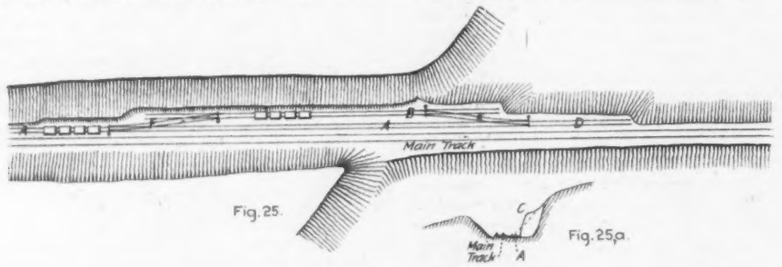


Fig. 25.



Fig. 25a.

After a side track has been laid in the first cut made by one of the methods described above, the steam shovel begins work at A, Fig. 26, loading cars standing on the side track, and some of them extending out on the main track. At first not more than ten cars should be coupled to the engine, so that the train can quickly run into the side track on the approach of a main line train, and not delay its passage. After the steam shovel has advanced a train-length, the full number of empty cars can be coupled to the engine, as they will all be on the side track while being loaded.

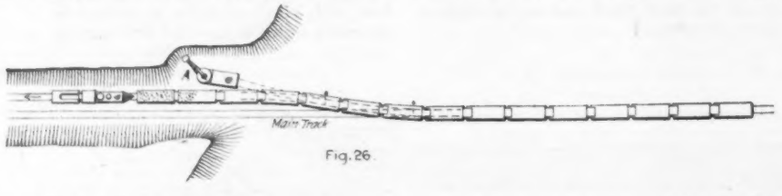


Fig. 26.

(To be continued.)

## PERSONALS.

Mr. Luther Dean has been elected City Engineer of Taunton, Mass.

Mr. M. W. Sherrerd has been appointed City Engineer of Troy, N. Y.

Prof. E. T. Nelson, of Delaware, O., has been elected President of the Ohio State Board of Health.

Mr. W. P. Rice has been appointed City Engineer of Cleveland, O., which position he held some years ago.

Mr. F. A. Dunham has been appointed engineer in charge of construction of pavements at Hornellsville, N. Y.

Mr. D. W. Hemming, Assoc. M. Am. Soc. C. E., is Chief Engineer of the Baltimore Belt R. R. tunnel, and not D. W. Henning, as stated by mistake in our last issue.

Mr. Andrew Rinker and Mr. Olaf Hoff have entered into partnership to carry on a general engineering and contracting business, and have established offices at Minneapolis, Minn.

Mr. Horace See, of New York, delivered a lecture, illustrated by the stereopticon, on "The Development of the Steamship," before the students of the Rensselaer Polytechnic Institute at Troy, N. Y., May 18.

Mr. Henry L. Leach, of Boston, Mass., dealer in railway machinery and supplies, and formerly Superintendent of the Hinkley Locomotive Works (which collapsed a few years ago), died May 15 at the age of 72.

Mr. Alexander Potter, Assoc. M. Am. Soc. C. E., has removed his head office from Olean, N. Y., to 137 Broadway, New York city, closing the former office. He has been engaged to design a system of water supply for Orrville, O.

Mr. Albert W. Nickerson, formerly President of the Mexican Central Ry. Co., died at Dedham, Mass., May 17. His uncle, Mr. Thomas Nickerson, was the first president of the road, and Mr. A. W. Nickerson was from 1883 to 1888 a member of the Board of Directors.

Mr. Chauncey H. Snow died at Washington, D. C., May 21, at the age of 60. He was one of the engineers engaged on the Hoosac Tunnel, and rendered valuable services to the government during the war. He was a government director of the Union Pacific R. R.

Mr. John A. Miller, of Goshen, N. Y., has resigned his position as Superintendent and Hydraulic Engineer of the Pierce Artesian & Oil Well Supply Co., New York, in which position he has had charge of the construction of water-works on the gang-well system for a number of years.

Mr. A. V. Powell has removed his office to the Chamber of Commerce Building, Chicago. He makes a specialty of consulting engineering work in hydraulics, and has been engaged by the North Waukegan Land Association as Consulting Engineer on the large docks it is to build; also to prepare plans and specifications for a system of sewerage at St. Joseph, Mich.

Mr. Ira N. Hollis, Passed Assistant Engineer, U. S. N., has accepted the professorship of mechanical engineering at Harvard University. Mr. Hollis entered the navy in 1874, from Kentucky; he was on special duty as instructor at Union College from 1881 to 1884, and for three years he was one of the inspectors for the construction of the new cruisers at San Francisco. He has written many valuable professional papers.

Mr. John W. Hill, Cincinnati, O., has been engaged by the trustees of the Southern Ohio Asylum for the Insane, at Dayton, O., to remodel the water-works and fire protection system for the institution. The work will include an ornamental water tower. He has also been retained by the Sewer Commission of Van Wert, O., to investigate and report plans for a general system of sewerage. The Greenville, O., water-works upon which he is now engaged, will be completed and in service about Sept. 1.

Col. David C. Houston, Engineer Corps, U. S. A., died suddenly in New York on May 18. Colonel Houston graduated from West Point in 1856, and was appointed to the Corps of Engineers. He was made a first lieutenant in May, 1861, and his record during the Civil War was an enviable one. He was twice breveted for gallantry in action, and was promoted to Captain in March, 1863. He was made a Colonel of Engineers July 2, 1889, and since that date he had been engaged upon river and harbor work in the port of New York. Colonel Houston was about 60 years of age, and was born in New York State.

Mr. A. W. Locke, M. Am. Soc. C. E., died at North Adams, Mass., May 14. He was born in 1846, served in the navy during the civil war, and then took up the profession of engineering. He was assistant engineer on the Hoosac Tunnel from 1868 to 1876, and Engineer of Maintenance of Way on the Troy & Greenfield R. R. until 1878, when he was appointed Manager and Chief Engineer of that road and the Hoosac Tunnel. He held this position until 1887, when the road and tunnel were sold to the Fitchburg R. R. He then engaged in private practice, and made a special study of the grade crossing question, was chairman of the commission on the abolition of grade crossings in Massachusetts, and also served on special commissions at Northampton, Worcester, and Springfield, and at Buffalo, N. Y.

## NEW PUBLICATIONS.

SKELETON CONSTRUCTION IN BUILDINGS: With Numerous Practical Illustrations of High Buildings. By William H. Birkmire, author of "Architectural Iron and Steel," etc., New York. John Wiley & Sons, 8vo.; 75 pp., illustrated; $3.00.

The technical portion of this work contains little new information, and the tables of dimensions, etc., are those usually found in such hand-books as are issued by Carnegie, Phipps & Co. The chief value of the book lies in its "numerous practical illustrations of high buildings," though these would have been more useful to designers had the author dealt more with details in his illustrations and less with architectural front elevations. Nevertheless, the specifications of a number of the higher and newer office buildings in New York and elsewhere and the New York building laws have been very fully abstracted, and much interesting and useful data have thus been brought together.

CAST IRON COATED WATER-PIPE. 8vo; pp. 12. Chicago: Robt. W. Hunt & Co.

This is a republication of a report of a committee of the American Water-Works Association on the above subject, made in 1890, and includes specifications for cast iron pipe. The committee was composed of Messrs. Thos. Y. Yardley, M. Inst. M. E.; S. Bent Russell, M. Am. Soc. C. E., and A. J. Guilford.

### TRADE PUBLICATIONS.

SEWER CASTINGS, ROLLERS, ETC.—Thomas Carlin's Sons, Allegheny, Pa.; 8vo.; pp. 16; illustrated.

This is an illustrated catalogue and price list of iron sewer inlets, traps, manholes, etc.; it also gives particulars of rock crushers, concrete mixers and horse rollers, etc.

LOCOMOTIVES AND CARS.—A. S. Males & Co., Cincinnati, O. Catalogue No. 16; 16mo.; pp. 48, illustrated.

This is an illustrated catalogue of second hand locomotives and cars for sale, including standard and narrow-gage engines of various types, steam motors, passenger, sleeping and freight cars, steam shovels, etc. There are also a number of iron bridges listed for sale. Dimensions and particulars of the material are given.

## SOCIETY PROCEEDINGS.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting on May 6, Mr. John Birkinbine, President, in the chair, and 42 members and visitors present, Mr. Birkinbine referred to some of the engineering features which impressed themselves upon him during a recent trip in Mexico. He referred to the difficulty of locating and constructing railways in a country where the supplies and even water had to be carried long distances, and instanced the necessity at present of some of the railways attaching one or two tank cars of water behind the locomotive tender so as to cross waterless plains of 100 miles or more. He gave a table of the different elevations of the 6,831 miles of railway in Mexico, which showed that about one-half is above a level of 5,000 ft. above tide and one-half below that height; of the higher portion some 200 miles of the tracks are laid from 8,000 to slightly over 10,000 ft. above sea level. He described the general alinement and profiles of the various railways, and illustrated this by diagam; referred to the difficulties of construction and cost of some of the roads, and laid stress upon the liberal use of metal ties, which meet with favor from engineers, managers and contractors. He also discussed the measures which had been taken in former times to drain the city of Mexico, and referred to the present canal and tunnel, the former requiring the handling of 12,000,000 cubic metres of earth.

The secretary read a paper on, "The Preparation of Portland Cement—The Various Systems of Grinding the Cement," by Pierre Giron, in which the author called attention to the qualities of the burnt product of the Portland cement kiln, and the desirability of reducing the clinker to a fine powder. While the quality of the cement was determined by the neat test only, the matter of fine grinding did not receive much attention, but the sand test now generally adopted shows conclusively that the value of Portland cement is increased by fine grinding to an extent that warrants the slightly greater expense to the consumer. A table showing the results of tests of cement mixed with three parts of sand by weight, made into briquettes pressed in the molds, according to the European method, and of others made to the consistency of mortar used in practical work, according to the American method, showed conclusively the value of fine grinding.

Results of sieving the cement and of obtaining a fine residue by the water method were mentioned, and the various machines used to reduce the clinker to the requisite fineness were described in detail and illustrated by drawings thrown on the screen from the projecting lantern. The speed of operation and the necessary horse-power were given in most cases, and the Morel ball pulverizer was recommended for the quantity of material produced per hour and the advantage that it can be run continuously day and night.

The paper closed with a description of two new methods of screening, and called attention to the fact that "remarkable progress has been made during the past few years toward the solution of this, one of the most difficult problems of the cement industry. It may well be said now that the grinding of Portland cement has about reached its limit of perfection, since it is possible to get at low cost a ground product of extreme fineness."

In the discussion, Mr. Robert W. Lesley said that the facts stated are, for the most part, ancient history, and that much of the machinery claimed to be in operation in cement works, is hardly to be found in mills built of late years. In answer to a reply made by Mr. Giron to my discussion on this last paper, and published in the proceedings of the Society's last meeting, I would say that I am ready to substantiate both of the facts stated by me: 1. So far as the cost of oil and coke—the figures as to quantities that I represented were taken from Mr. Giron's own paper. The price of coke was figured at the cost of coke in the cement kiln, allowing a very large margin for handling it, and the price of oil was figured from prices given by the Standard Oil Co., allowing also a margin for handling it from the cars to the tanks, and thence to the rotaries. 2. As to the disintegration of briquettes, I would state that I have here briquettes made, both neat and sand mixtures, of a cement manufactured in rotary kilns, and representing the product of four separate years of a mill manufacturing under the rotary process. All of these briquettes show disintegration at periods of a year and over, while briquettes of three other American cements and two foreign Portland cements, made in pairs at or about the same time, and kept under the same conditions as those first mentioned, show no signs of disintegration. One of the rotary kiln briquettes actually showed disintegration in sand mortar at a period of three months. In view of the fall of the St. Nazaire bridge in France, ("Engineering," April 22, 1887), after seven years' use, and the breaking down of the Aberdeen Docks in Scotland (Bamber & Carey's paper, Institution of Civil Engineers, London, 1892), after an almost equal period of use, both built with Portland cement regularly burned, though of improper materials, the fact that cement burned in rotary kilns has been in use in this country for three years, as stated by Mr. Giron, is no "contradiction" of the facts I have stated above, and, in point of fact, in the completing of the Reading Terminal, mentioned by Mr. Giron, a cement other than a rotary kiln cement was principally used.

Now, as to the reasons for the opinion I have advanced, that cement made by the rotary method does disintegrate, the facts are these: At the works whence the cement came, of which the disintegrated briquettes were made, the raw mixture is composed of a limestone and a cement rock, the former being much higher in specific gravity and density than the latter. The limestone contains a small percentage of silica and alumina, while the cement rock contains a large percentage of silica and alumina. Inasmuch, therefore, as these two widely different materials are fed in the form of a slightly moistened powder into a rotary cylinder, it is easy to see that a mechanically combined homogeneous material is not presented to the flame for the chemical operation of calcining. For this reason it can be seen that the flames act differently upon the two materials, each of which has a very considerable variation in the clinkering point, the cement rock clinkering at a much lower temperature than the limestone. That this is the case can be seen by screening on a 10,000-mesh sieve the cement so manufactured, and comparing its residue with the residue of other well known English, German or American cements. This I have done, and the powder I have here shows grayish-green pepper-and-salt residue from the rotary kiln cement, and a greenish-black residue from the cement made in ordinary kilns; the white particles in the former residue indicating the presence of small particles of lime not driven to clinkering point in combination with silica and alumina, as should be the case in well-burned cements. The dusting and the checking of the briquettes at the long periods show the final results of these portions of uncombined lime.

Mr. Thos. D. Whittaker said: We are burning cement in a rotary kiln, and do not find that it disintegrates. We do not, however, add lime in the burning, which may account for this to some extent.

Mr. Lesley: After stating that unless some new mills are introduced for economical grinding, the manufacture of Portland cement in this country will become impossible, the writer recommends the Morel ball mill, as possessing the "remarkable advantage that it can be run day and night." Such a statement to a cement manufacturer, who is running day and night not less than 50 run of stone and eight or ten Griffin mills, is certainly information of a most startling character. L. F. Rondinella, Secy.

NEW ENGLAND WATER-WORKS ASSOCIATION. The twelfth annual convention of the Association will be held at the Bay State House, Worcester, Mass., June 14, 15 and 16. The following papers will be presented: "An Experience with a Stand-Pipe," John C. Chase, C. E.; "Points of Experience," Edwin Darling; "Is the Game Worth the Candle," John Thompson, M. Am. Soc. C. E.; "Water Pipe Trenches versus Good Roads," (illustrated by stereopticon), W. E. McClintock, M. Am. Soc. C. E.; "A Description of the Hydraulic Laboratory at the Massachusetts Institute of Technology, and the Work Done Therein," (illustrated by stereopticon), Prof. Dwight Porter; "The Covered Reservoir at Brookline, Mass.," F. F. Forbes; "The Location, Construction and Laying of a 54-in. Steel Submerged Pipe in Skaneateles Lake for the Syracuse Water-Works, Syracuse, N. Y.," Wm. R. Hill, M. Am. Soc. C. E.; "The Works of the East Jersey Water Co. for the Supply of Newark, N. J.," Clemens Herschel, M. Am. Soc. C. E.; "Purification of Water by Freezing," Prof. Thos. M. Drown; "Details of Pipe Castings and Coatings," a discussion to be opened by Dexter Bracket, M. Am. Soc. C. E.; "Recent Practice in Pumping Machinery" (illustrated by stereopticon), F. W. Dean, M. Am. Soc. M. E.

In addition to the papers there will be general discussions on the following subjects: "The Filling of Service Pipes by Sedementation or Tuberculation," "Anchor Ice," "Air Valves."

The usual exhibit of water-works appliances by associate members has been arranged for by providing space on the first floor of the hotel where the convention is to be held. Information regarding the exhibit can be obtained from Mr. Chas. H. Baldwin, Box 2410, Boston. Board and room at the Bay State House will be furnished at $2.50 per day, and at the Waldo House at $2 per day.

On Thursday, June 15, at 1 p. m., there will be an excursion, at the invitation of the Worcester water department, to the Institute and Elm parks, the works of the Washburn & Moen Co., the Union Meter Co. and Worcester sewage purification plant, where chemical precipitation is used.

Special carriages will be provided during the convention for ladies in attendance to visit different parts of the city.

On Friday, June 16, the members of the Association and lady members will be entertained at Lake Quinsigamond by the Union Meter Co., of Worcester, cars leaving the Bay State Hotel at 10 a. m.

Further information can be obtained from the secretary, Mr. R. C. P. Coggeshall, New Bedford, Mass.

CIVIL ENGINEERS' CLUB OF CLEVELAND.—At the meeting on May 9, the president in the chair, and 30 members and visitors present, Mr. Cully introduced the following resolution:

"Resolved, That we, the Civil Engineers' Club of Cleveland, Ohio, adopt the Ohio legal standard time, and that hereafter the secretary shall designate 'standard time' in the call for meetings of the club." On the motion of Mr. Searles this was referred to the executive board for action.

Mr. C. W. Hopkinson then read a paper on "The Proper Critical Attitude Engineers and Architects Should Assume in Attending The World's Columbian Exposition." Frank C. Osborn, Secy.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—At the meeting at the Society's rooms in Montreal May 18, a paper on "The Temiscouata Railway," by Mr. R. Adams Davy, was read, and the discussion on Mr. Baillairge's paper on "The Quebec Land Slide" was resumed. C. H. McLeod, Secy.

### COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF MINNEAPOLIS.
June 1. Secy., E. Nexsen, 504 Kasota Block.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
June 2. Secy., F. K. Smoot, 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
June 2. Secy., O. Von Geldern, 719 Market St., San Francisco.
ENGINEERS' CLUB OF PHILADELPHIA.
June 3. 1122 Girard St. Secy., L. F. Rondinella.
SWEDISH ENGINEERS' CLUB.
June 3. Secy., P. Valentine, At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago. Secy., John Ericson.
ENGINEERS' CLUB OF ST. LOUIS.
June 7. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 7. Secy., F. Collingwood, 127 East 23d St., New York.
WESTERN SOCIETY OF ENGINEERS.
June 7. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
June 8. Secy., F. W. Mowbray, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
June 8. Secy., W. G. Kirkpatrick, Nashville, Tenn.
MONTANA SOCIETY OF CIVIL ENGINEERS.
June 10. Secy., G. O. Foss, Helena.
ENGINEERS' CLUB OF KANSAS CITY.
June 12. Secy., Waterman Stone, Baird Building.
WISCONSIN POLYTECHNIC SOCIETY.
June 12. Secy., M. F. Schinke, City Hall.
DENVER SOCIETY OF CIVIL ENGINEERS.
June 13. Secy., F. E. King, Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
June 13. Secy., Parker N. Black, Capitol Block, Atlanta, Ga.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
June 13. Secy., F. C. Osborn, Case Library Bldg.
NORTHWEST RAILROAD CLUB.
June 13. Ryan Hotel, St. Paul. Secy., W. D. Crosman.
NORTHWESTERN SOCIETY OF ENGINEERS.
June 13. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
MASTER CAR BUILDERS' ASSOCIATION.
June 13. Lakewood, N. Y. Secy., J. W. Cloud, Buffalo, N. Y.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
June 14. Wichita, Kan.
NEW ENGLAND WATER-WORKS ASSOCIATION.
June 14, 15, 16. At Worcester, Mass. Secy., R. C. P. Coggeshall, New Bedford, Mass.
NEW YORK RAILROAD CLUB.
June 15. Secy., H. G. Prout, 73 Broadway N. Y.

# ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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*ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.*


In its last issue "Bradstreet's" publishes a series of answers sent in to questions relating to the condition of country roads and the effect of these prevailing conditions upon the prices of agricultural products and farm lands, mercantile collections, interest, etc. The answers, which number nearly a thousand, came from merchants, farmers, marketmen, legislators, county officials, etc., scattered over 28 states east of the Rocky Mountains. These returns show that the general condition of the country roads vary widely with the section of the country containing them. The southern half of New England appears to have fairly good, interior highways; New Jersey has relatively the best roads and is most rapidly extending its hard road system; in New York, Pennsylvania and Maryland there are some excellent roads, and the same may be said for some of the other states in sections near large cities. But the western and southern states have comparatively very few good roads, when those of New England and New Jersey are taken as standards. Touching the question as to the average period during wet seasons when such roads are out of condition sufficiently to check wagon traffic, the answers vary. In New England and New Jersey this period averages from one week to one month, and is generally due to snow. In Pennsylvania and New York, this period is stated at one month to six weeks; Ohio averages from one to two months; Kentucky reports, for spring and fall, a delay of from one to three months, and the Southwestern states about equal New York in this respect. From the Southern states proper, there are fewer reports of "muddy roads," owing chiefly to different conditions of soil and climate. As to the effect of this delay upon prices of farm produce, the opinion seems to be that bad roads unduly advance the prices in cities and towns, because the farmer cannot bring them to market. How much the farmer would eventually get were the roads good and all the surplus material in the market is not given; but the statement is made that he could pay his road tax from the extra profit of winter sales could he have reached the buyer.

Our contemporary says that the most ambitious question sent out was one asking information as to the "total direct and indirect excess cost" annually to farmers and country merchants by reason of bad roads and interrupted wagon traffic. This is a very broad question; and, as was to be expected, the number of replies was comparatively few. But from the few received from "exceptionally well-informed people" our contemporary is led to believe that the annual loss to the whole United States, by reason of bad roads, is generally under rather than over stated; it indicates that the sum of $240,000,000 per year might be near the mark. This is an enormous total, and if properly expended would do much toward improving our main highways, at least: but we repeat the remark made by us before, that all estimates of this loss, as now frequently published, are based upon an almost utter lack of any reliable information as far as the whole country is concerned. We know our country road system is generally bad, and we would like to improve it; but before any real advance can be made we must handle the question as we would any other business transaction, and first find out how much we lose under existing conditions, how many miles the several classes of roads aggregate in each state, and how much it would probably cost to put them in better condition in some fixed period of years. Under any conditions it will take many years to work out any radical improvement; but the several states could attack the problem more intelligently and with better prospect of success if they had this information available. It is a question whether this data had better be collected by the National government or by the individual states, as Massachusetts has done; but there is no doubt that no reliable estimates of loss by present conditions or benefits by better methods can be made until this investigation is first instituted by some one.

Electric railways were originally introduced as a substitute for horse cars in town and city traffic, and the promoters of the first lines saw little further occasion for them. But in an exceedingly short time their field of usefulness has broadened, until they are even now in many states a successful rival of steam railways for passenger traffic over lines of considerable length. Their relative cheapness of construction and ease of operation well adapt them for use in connecting centers of population and business with outlying towns and suburban districts, and this is being done all over the country. Brooklyn already has a system of electric railways stretching far out into Long Island, and tieing to it the number of small villages to the eastward. Newark, N. J., is in a similar manner reaching out for neighboring towns, and a line now building from Yonkers, on the Hudson, to New Rochelle, on Long Island Sound, will connect the several considerable towns on its route and make more accessible the many desirable building sites in that part of Westchester County. Lexington, Ky., is also contemplating the construction of at least two electric lines which would connect it with Paris, the county seat of Bourbon County, 18 miles distant, and with Versailles, the seat of Woodford County, 15 miles away. The avowed object of the projectors is to induce the farmers to come to Lexington to make their purchases. In Pennsylvania a projected electric railway would parallel the main line of the Pennsylvania Railway between Philadelphia and Lancaster, a distance of 70 miles; and those who are asking for the charter believe that the frequency of service and stops and the ease of getting at the cars will divert sufficient passenger traffic from the steam railway and encourage others to travel who use the existing line very little. A similar project in Illinois proposes a line right across the state from east to west, cutting present steam lines and in this case serving as feeders to them. These few among the many electric railway enterprises already started in the United States show a rapidly growing appreciation of the advantages of the system as a means of affording rapid and convenient transit to country districts, and in most cases they will serve as feeders to steam railways running through the sections thus improved, and tend to increase general traffic. The one thing yet wanting in these lines, as far as we know, is a service which includes the transportation of baggage and more valuable and compact parcels of goods. The suburban electric line that includes this service will well earn the gratitude of its patrons, and make money besides; for a convenience of this kind will greatly advance the desirability of the region traversed as a place of residence and thus increase the short-haul traffic, the most profitable traffic to the company.

Every now and then young men who are ambitious to become engineers ask our advice as to whether they should or should not spend the time demanded for a thorough technical training as a preliminary to practice. These correspondents are referred to a lecture upon the interdependence of abstract science and engineering, lately delivered before the Institution of Civil Engineers by Dr. William Anderson, who sums up the case when he says "that the time has passed when an engineer can acquit himself respectably by the aid of mother-wit alone, or by means of certain constructive instincts which have chiefly guided builders down to quite recent times." With a rate of growth far outstripping any of the older professions engineering has developed until, for very many of the enterprises intrusted to it, the employment of men of the very highest scientific culture combined with the widest practical experience can alone insure success. Watt, Smeaton, Brindley and George Stephenson achieved success and made themselves famous without the aid of scientific schools, because none such existed in their day. But they were hard students nevertheless, and Watt made his advance in engine-building by first working out the abstract needs of the case and detecting the errors of judgment and design which had befogged his fellow-inventors for centuries. In the light of modern discoveries abstract science can scarcely be said to have had a recognized existence even in the later day of Stephenson, and he and his predecessors named labored toward a passing success which was very insignificant in its dimensions when compared with modern achievements of a similar type.

Time is too short and the world moves too fast to permit a young man of this generation to hope for any professional success unless he enters upon his life work well equipped at all points. Without any technical training and with a common-school knowledge of mathematics a young man may soon learn the mere rudiments of the profession of civil engineering, for example, and he may succeed in learning more; but he is handicapped from the start, compared with him who enters the field from a good engineering school. In the first place he does not know what or how to study and wastes years over matter that is of little or no benefit; he is without the advice of the trained instructor, and loses the advantage of the mental discipline that is one of the chief ends of a scientific course. By superhuman labor and exceptional intellectual endowments he may succeed at last, but it is a question even then whether the result is worth all it has cost. The men who achieve great success, in the application of modern sciences to the broad field of engineering, in spite of every disadvantage are very few in a generation, and our candid advice to all aspirants to engineering fame is to obtain all the technical and scientific culture they can, when they are still young and their brains are most receptive and capable of development. Youth is a treasure that no man can afford to waste when the acquirement of scientific knowledge is in question; and it is only by continuous, well-directed study that a man can become an engineer in the present acceptation of that term.

## THE RAPID TRANSIT PROBLEM IN NEW YORK.

As we foretold in our issue of May 11 the "hopeful" negotiations between the New York Rapid Transit Commission and the Manhattan Railway Co. result in nothing, and both parties again assume an attitude of masterly inactivity. As we then said the Manhattan company has all the advantages of the position and can well afford to await developments; especially as some members of the commission seem to think that the city of New York is bound to accept any terms that the Manhattan company is graciously disposed to grant.

It is again timely to remark that this commission, or some more business-like successor thereto, should drop back to the position of 1891, when the com-

mission was created for a specific purpose, and begin all over again. The present commission has indeed selected a route after these years of labor; but as far as that is concerned, it is still a serious question whether the convenience of travel would not have been as well met and the conditions of construction much better met by a line parallel to Broadway instead of one located in that narrow stretch lined with high and costly buildings. But beyond selecting a route the commission has actually accomplished nothing. The attempted sale of the franchise last December was a lamentable fizzle, for reasons which we pointed out at the time. With sweeping and ample powers to impose conditions and terms, the commission deliberately selected those least likely to attract bona fide bidders and which also least guarded the interests of the city. This scheme was not even seriously considered by those who would have doubtless stood ready to handle one of the greatest enterprises in the country, had there been a decent guarantee of good faith on the part of the city and some proper inducement and protection for the vast investment called for. The result was foretold in the terms of the sale and the time and money expended in preliminaries was wasted.

The problem to be solved is an exceedingly difficult one; but why should not the commission try another solution of it, something like the following: In the first place, make all the requirements of the proposed rapid transit service for New York, on some fixed route, as plain as words can make them, as to speed of trains, motive power, seating capacity, fare, service of express and local trains, heat, light, ventilation, etc. These are requirements that can be settled upon in advance in every detail; yet they were not expressed at all, or only in the vaguest terms, in the specifications submitted to the public last November. With a full knowledge of what is demanded, and with the rights of both the city and the prospective bidders fully and equally guarded, then let bidders submit their own plans in detail, estimates and evidences of good faith and financial ability to carry on the work. The exact type of road built is not at all essential, so that it fully meets the imposed conditions of service combined with public safety. A board of competent engineers can easily determine which plan among those submitted is best adapted to the work intended; and if a good plan is submitted which is unbacked by sufficient capital to carry it out, it could be provided that the plan should be bought and bids invited upon it in a later competition. It should be distinctly understood that the present and future interests of the city are to be guarded most carefully; but it should also be understood that no capital will be risked in an undertaking of this magnitude unless the rights of capital and of bidders are also as fully protected in every possible detail.

The chief objection to the documents issued previous to the proposed sale of franchise was their exceeding vagueness as to details of service demanded and as to the position of the bidders under it, who would have had to bind themselves to an utterly one-sided bargain. They embodied the maximum of possible loss and the minimum of plain duty expressed and of protection even to the most honest intent to carry out the terms of the contract. The engineering standard plans submitted at the time were also of little real value, for they were based upon admitted ignorance of the underground conditions of the route, and the terms of sale placed all responsibility for the safe conduct of the work upon the contracting party. These plans simply handicaped the bidder by compelling him to adhere to certain types of construction without providing sufficient data for estimating the probable cost. It is for this reason that it would seem better to enlist the whole engineering ability of this or any other country in the submission of plans and estimates, with or without actual bids for the work, and upon the fuller data thus obtained to decide upon the ultimate details of an exceedingly important and costly public work.

And above all things provide that the ownership of the rapid transit lines of New York should not be forever in the hands of private parties, by the absurdity of a 999-year lease, but so fix the conditions of the sale of the privilege that the city shall derive some direct revenue from prospective gross receipts and by some equitable arrangement own the lines within some reasonable period of time. The commission was appointed to provide rapid transit for the better convenience of the people of the city of New York; and if not built by the people directly, they should be owned by the people as soon as the first claims of capital invested can be satisfied.

## THE RAILWAY ACCIDENT AT LAFAYETTE, IND.

We have delayed discussion of the serious railway disaster at Lafayette, Ind., which occurred on May 7 until a full record of the circumstances which caused the wreck should be available. A valued correspondent, whose letter appears in another column, has furnished us these facts, and a careful perusal of this letter, especially that part of it relating to the failure of the brakes, should precede the reading of what follows.

The important facts to be noted are that the engineer gave the whistle signal for brakes near the top of the grade, that the conductor responded by opening the conductor's valve, and that the brakes still failed to apply, proving that the air had escaped from the train pipe and auxiliary reservoirs. The delay which then ensued before the hand brakes were applied caused the train to attain so high a speed at the foot of the grade that it jumped the track at a sharp curve, with the disastrous results already noted.

The ill-fated train was the night express from Chicago to Cincinnati, leaving Chicago at 8:30 p. m. At Kankakee, 55 miles south, engines were changed and the train went on its way, making in the next 54 miles, to a station called Fowler, nine stops at local stations, according to the official timetable. From Fowler to Lafayette, 28 miles, no stops are scheduled in the official timetable, and (for the last 18 miles certainly and probably for the whole 28 miles) there is not a single grade which would require the application of brakes. Evidently the air brake pump was working all right when the train pulled out of Kankakee. If it had not been, the next nine stops could not have been made with the air. Possibly at the last one or two of these stops the pump governor failed to start the pump and the brakes were not recharged; but this does not seem likely, for if the pump was stopped at any station before the stop at Fowler the engineer's attention would probably have been called to it. Either he would have found the train running past the point where it should have stopped, or he would have noticed the fall in reservoir and train-pipe pressure, as shown on the gage beside the brake valve at the time he applied the brakes; or if neither of these things warned him, then surely either he or the fireman would have noticed the absence of the familiar sound of the pump exhaust as the train came to a stop.

All these things, while not absolutely conclusive, point to a correct action of the brakes before reaching Fowler, and if this was the case, the loss of air must have taken place during the 26-mile run from Fowler to the top of the grade approaching Lafayette. The schedule time for the 28 miles, Fowler to Lafayette, is 56 minutes. Suppose the pump governor were badly stuck and gummed, so badly that it would move under the sudden blow due to application of the brakes, but would not start when the pressure in the train pipe gradually fell by leakage, and the load tending to open the steam valve was thus applied very gradually. Suppose in connection with this that the train pipe on this 10-car train was leaky enough to let the air pressure in it and the reservoir's fall from 70 lbs. to 20 lbs. during this run of nearly an hour, a supposition which is far from extravagant. The train would then arrive at the top of the grade with the air pressure so low as to be of no practical use, and this appears to have been the case.

On the other hand, we may suppose that some malicious person, while the train was standing at Fowler, closed the cock in the train pipe back of the tender. With a slightly leaky train pipe the air would then gradually escape as before stated, and the brakes back of the tender would be inoperative. But if, as is probable, the locomotive was equipped with driver brakes, this theory is less probable than our previous supposition, for the engineer would still have had the driver and tender brake with which to control the train on the grade, and would surely have been able to hold it down to a moderate speed.

Apparently the engineer discovered that his air pump was inoperative and the pressure was gone only when his train had already begun to increase its speed as it struck the long down grade into the city of Lafayette. It certainly seems surprising at first sight that either by reversing the engine or use of the hand brakes the train was not slowed down enough to keep the track as it entered the station; but on a little reflection it is not as strange as it seems. The train's regular speed between Fowler and Lafayette was 30 miles per hour. The engineer would probably not apply the brakes on the down grade until the speed had been considerably increased, say to 40 or 50 miles per hour; and when he found his air was gone, he was quite excusable for hesitating before reversing his engine. Had the hand brakes been applied, even partially, the train was still in no material danger, and to reverse an engine at 40 miles an hour with a 10-car passenger train behind it means a considerable risk of a derailment. It does not seem so strange, after all, therefore, that only when he found the speed of the train increasing to a highly dangerous degree, notwithstanding his calls for the hand brakes, the engineer should have reversed his engine.

As respects the failure to apply the hand brakes, however, it appears to be undeniable that the trainmen were culpably negligent. At the same time it is in order to inquire on how many roads a sudden call for hand brakes on a heavy express train at 1:15 a. m. will meet with any quicker response. The force whose immediate duty it is to respond to the call for brakes was in this case a conductor and two or possibly three brakemen. The conductor seems to have been on the alert and to have done his duty so far as possible. The brakemen accomplished nothing, so far as we know. What was the reason for this failure? Here was an hour's run without a single stop just after midnight. An excellent chance for a sleepy brakeman to drop into a comfortable seat for a doze, and this is what nine men out of ten would do. He is awakened by a series of repeated blasts from the whistle. Was it the call for brakes? He is not sure of the number, and thinks it was probably a cow on the track. But there it comes again; no doubt about it now, and he hurries to the brake wheel. There is no trouble in getting at the brakes on the day car or the smoker; but the four vestibuled cars in the rear and the mail, express and baggage cars in front are another matter. The express car in these days of train robberies may have the doors locked, and the same may be true of the postal cars. In the baggage car trunks may be piled in the way of passage, and take it all in all the brakes are not likely to be set up on these four cars for several minutes at least. In the vestibuled cars in the rear the case may be quite as bad. Where the first vestibuled car is coupled to the ordinary day car one finds the brake wheel on the day car removed from its staff, and it cannot be put on because the vestibule comes directly against it. In the vestibule cars themselves the folding doors of the vestibule must be opened to reach the brake wheel, a task which occupies several precious seconds.

But let us suppose that these difficulties are overcome and the brake wheel is reached. How much braking force can the average passenger brakeman exert on a 12-wheel Pullman or Wagner car, weighing, say, 90,000 lbs.? The brake wheel has been somewhat reduced in size to keep it out of the way of the vestibule and the steps. In some cases this reduction has been compensated for by bevel gearing between the brake staff and the shaft on which the chain winds. Whether all railways are as careful as the Pennsylvania in this matter we do not know. The release springs are sometimes so stiff that a good part of the braking force is consumed in bending them, and the middle wheels carrying one-third the weight of the car are, as a rule, wholly unbraked. Thus taking one thing with another there is reason to estimate the retarding effect of the hand brake on a vestibuled sleeper at a low figure.

Let us next see how long a time was available for getting the brakes on the train. We may fairly suppose the train to have been running at its schedule speed of 30 miles per hour as it reached the top of the grade. From this point to Lafayette, two and a half miles, there is a total fall of 185 ft. Calling the average grade necessary to offset the

friction of the train in motion 0.4%, we have a vertical fall of 53 ft. as that required to keep the train in motion at the same speed as that at which it reached the top of the grade. This leaves a total vertical fall of 185 — 53 = 132 ft., which was effective in increasing the train's velocity down the grade. The velocity corresponding to this vertical fall* is 61 miles per hour, and adding this to the 30 miles per hour at which we suppose the train to have reached the top of the grade, the velocity at the foot would be 91 miles per hour. Actually the velocity was probably considerably less than this owing to the increased friction at increased speed, the reversing of the engine and the partial application of brakes on one or two cars.

Suppose the velocity was 30 miles per hour at the head of the grade and only 70 miles per hour at the foot. This would give an average speed of 50 miles per hour over the two and a half-mile run, or the whole run down the grade would be made in three minutes. Several seconds delay in the call for brakes, several seconds more delay in repeating the call, and the inevitable delay, greater or less, in reaching the brakes would consume a good share of these precious minutes.

In view of all these facts it seems no longer very strange that the ill-fated train was not stopped by the hand brakes; on the contrary, there seems much reason to believe that what happened on the train is what would happen on a similar train on any other railway under similar circumstances.

Doubtless many railway managers will consider the chief lesson of the Lafayette disaster to be the need for better discipline among passenger brakemen, and more convenient hand brakes; but is this, after all, the most promising method of preventing such accidents as that at Lafayette? It seems a hopeless task to discipline trainmen to be in readiness to respond to a call which may never come in the whole course of their service. The most promising direction for improvement seems to lie in the further improvement and perfection of the airbrakes, which is and must continue to be our main, and, as we have shown above, practically our only reliance.

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Work on the Chicago drainage canal has been delayed by high-water during April. While the contract required work to the amount of $1,106,649 to be done by May 1, only $386,159 had been paid out to that date. Several contractors are still engaging in installing their plant, and when this is all in place, the engineers believe that the contractors will soon catch up with their work. Hospitals have been completed at Willow Springs for the use of laborers, and Dr. Martin, as the district sanitary inspector, will compel contractors to comply with sanitary rules.

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The Massachusetts Institute of Technology has arranged for the following outside lectures for this year: A course on Railway Signaling, by Mr. George W. Blodgett, Electrician of the Boston & Albany R. R.; two lectures by Mr. E. P. North, and two by Mr. James Owen on Highway Engineering; two by Mr. James R. Freeman, on Fireproof Construction and the Hydraulics of Fire Protection; one by Col. Charles W. Folsom on Sewer Construction; one by Mr. Desmond Fitz Gerald on the Boston Water-Works, and four lectures by Mr. Eliot Holbrook on Railway Maintenance and the Arrangement of Yards and Stations. Engineers need not be told that the lecturers in each case are well known specialists in the several branches of engineering, forming the supplementary and valuable course.

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A novel method of food preservation is being developed by a Chicago inventor. The system is based on the claim that decomposition or putrefaction will not take place in an atmosphere of pure carbonic acid gas, and the inventor proposes to build an air-tight vertical chamber, in which, by means of an endless chain, from which carrying trays are suspended, meats, fruits, vegetables and similar perishable articles can be conveniently lowered. The gas being considerably heavier than air, it will remain in the shaft, even though it is opened occasionally at the top to put in or take out articles. According to Sternberg's "Manual of Bacteriology," certain species of bacteria grow as well in an atmosphere of carbon dioxide as in the air; other species have their growth slightly restricted, and still others are killed by exposure to the gas. That all the various species which cause decomposition come under this latter class seems rather doubtful, and it will require some extensive experiments to prove it.

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* See table 118, p. 335, "Economic Theory of Railway Location."

## LETTERS TO THE EDITOR.

### THE RAILWAY ACCIDENT AT LAFAYETTE, IND.

Sir: The union station at the foot of South St. was this morning (May 7) the scene of a most disastrous railway wreck. The south-bound passenger train on the Cleveland, Cincinnati, Chicago & St. Louis Ry., a fast vestibule train, due here at 1:15 a. m., was wrecked just as it entered the sheds of the union station, the accident ending ten lives and injuring as many more people (Eng. News, May 11). It is generally supposed that the accident was due to the failure of the air-brakes. This supposition is probably correct. Why the brakes failed to work will probably never be known, as the engineer and fireman were killed instantly.

The C., C., C. & St. L. Ry. trains enter the city from the west, over the Lake Erie & Western R. R. tracks. About 2½ miles west of the city the tracks are on a 1% down grade toward the city, this grade increasing to 2% about one mile west of the station. This latter grade is continuous to the west end of the bridge crossing the Wabash River. From this bridge west, for a distance of about one mile, the tracks are laid upon what was originally a trestle about 20 ft. in height. Within a short time, however, this trestle has been filled in, making a solid embankment. Upon this embankment the tracks are laid in the form of a reverse curve, both curves being of very long radius. The bridge is a single track structure, consisting of four spans, each about 150 ft. in length. About 150 ft. east of this bridge the tracks pass over a plate-girder of about 80 ft. span. Over these two structures the track is perfectly straight, until about 50 ft. from the station the track bends sharply to the south through a 20° curve.

A careful examination of the tracks develops the fact that at least one of the cars left the rails at the switch located upon the plate girder bridge previously referred to. The engine probably left the track at the frog. A bystander asserts that when the engine left the rails it made a clear jump of at least 20 ft. The track was not in good condition, and is not now, the rails having been spiked down again after the accident. It is probable, however, that the track could not have saved the train on account of the terrific speed. A gentleman who was a passenger upon the train, and who was in the day car, asserts that this car left the rails as it rounded the curve at the west end of the bridge. A careful examination of the floor of the bridge, however, shows no indication of a derailment having occurred upon the structure. Why the brakes failed to act is an interesting question. The conductor of the train, as well as the passengers, state that the engineman called for brakes as soon as the train reached the down grade, 2½ miles west of the city. The conductor immediately pulled the rope in the car attached to the brakes, but there was no response, indicating that there was no air anywhere upon the train. An attempt was then made to set the hand-brakes, but such was the velocity of the train, only one was set before the crash came. As the train dashed into the station it passed a locomotive standing upon the side track. The fireman of this engine asserts that the engine of the passenger train was reversed, and the drivers were spinning backward. The brakes were in working order at the last stop made before reaching Lafayette, and various and sundry rumors are afloat as to the brakes having been tampered with by tramps who were seen on the train at Templeton.

In view of the condition of the track, the sharp

RAILWAY ACCIDENT AT LAFAYETTE, IND.

curve and the close proximity of the depot to the track, it is difficult to see just how a catastrophe could have been averted, even had the speed of the train been much less than it was.

A. E. P.

Lafayette, Ind., May 9.

The station is almost directly opposite the vertex of this curve, and not over 8 ft. from the tracks. In fact, the building is so close to the rails that the cars barely miss it when pulling into the station. It is customary for trains to approach this curve under full control and at a very low rate of speed. Sunday morning the train in question was on time, and its speed as it passed the bridge and approached the station has been variously estimated at from 60 to 90 miles per hour. The locomotive did not enter upon the curve, but jumped the track and made a dash across the yard into some loaded freight cars that were standing upon the Lake Erie & Western R. R. side tracks. The engine was followed by the mail cars, the express and baggage cars, and the smoking car. These were heaped up into a tangled mass of wood and iron, and were completely destroyed. The forward trucks were pulled out from under the day car, and that car, together with the chair-car and sleeping cars, remained upon the track, and were shortly after sent south. Three railway postal clerks were killed, as was also the express messenger. Of the passengers killed, all were in the smoker. The greater number of fatalities occurred upon the station platform. Hackmen and drivers, together with intending travelers, were congregated upon the platform awaiting the arrival of the train. So quickly did it all occur, they were unable to escape from the wild train, and were buried in the ruins. The corner of the depot was demolished, as were also the train sheds parallel to the tracks. The accompanying photograph gives a very good idea of the wreck as it appeared about an hour after the accident. It is taken looking toward the station from the south, and shows very clearly the curvature of the track as it approaches the depot from the west.

(We have discussed the circumstances in connection with this accident in our editorial columns. —Ed.)

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### RESULTS WITH THE NEW BALLOTING SYSTEM IN THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Sir: One of the most serious problems encountered in the management of national engineering societies is the election of its officers. Among the objects sought are the proper management of business affairs, and the maintenance of the dignity of the organization, combined with a representation on the board of the various parts of the country which are embraced in the membership. For these reasons the plan for nominations and election introduced last year in the American Institute of Electrical Engineers, and tested for the first time in the election of May 16, should be of interest. By the old plan no opportunity existed for distant members to take part, either in the nomination or election of officers, and, as but 25% of the membership was within a reasonable distance of the New York headquarters, it was obvious that the system in vogue was open to the objection of being unduly influenced by New York members. Experience has shown also that a letter ballot was a merely perfunctory indorsement of cut-and-dried nominations, so that in devising a new rule it was so arranged that the entire membership was given an opportunity to make suggestions,

The old plan was superseded because at the previous annual meeting a possible candidate for the presidency was asked if he would serve. Having given his consent, it seemed proper that he should be nominated, but the nominating committee appointed at the meeting for that purpose brought forward the name of another candidate. The gentleman who had conferred with the first candidate then nominated him in opposition to the candidate selected by the committee, and the latter was defeated. This experience led to the appointment of a committee for the revision of the rules governing elections, and the final acceptance of its report, which was adopted Sept. 27, 1892. By the provisions of the new rule the Secretary was required to mail to each member during the first week in February a list of members, a list of the offices to be filled, and a copy of the rule, with the request that nominations, propositions and suggestions as to desirable candidates be made prior to March 1. While this afforded an opportunity for distant members to express their preferences, only about 10% availed themselves of the privilege. At the March meeting of the council the suggestions were taken up, and the council selected an official ticket from among the names presented, as required by the rule. Out of 68 nomination slips Mr. Thos. D. Lockwood, of Boston, received the largest number of preliminary votes for the presidency, and he was selected as the apparent choice of the plurality of those who had taken sufficient interest in the matter to express their choice. The rule further provides that in addition to the complete ticket headed "Council Nominees" there shall be printed on the same sheet the names of all other eligible members proposed for the various offices; also a statement that the selection by the council shall not be considered as governing the choice of voters, but rather to aid them in selecting suitable names. The voting, however, must be restricted to the names on this sheet. According to the rule:

All names voted for shall be written, printed or otherwise marked on a single ticket or ballot, which shall be inclosed in a sealed, unmarked and unidentified envelope of any suitable size, to be in its turn inclosed in the voting envelope received from the Secretary. On this outer envelope the member shall add his signature and the postage stamp.

It has been felt by many that on account of the World's Columbian Exposition, and the accompanying Electrical Congress, the presidency was of unusual importance this year, and the fact that Mr. Lockwood had been for many years in the service of the American Bell Telephone Co. was used as the basis of a movement to run an opposition candidate. A circular was prepared and the official candidate was given to understand early in the campaign that, while he would have been a good enough candidate any other year, it was desirable that the president for 1893 should be absolutely independent of corporation influence. Prof. Edwin J. Houston, of Philadelphia, was selected as a candidate upon this platform, and the official ballots from the Secretary's office were followed two days later with a printed ticket bearing the name of Professor Houston at its head, and entitled "Members Ticket." This was accompanied by a circular signed by 30 prominent members, and a stamped envelope addressed to the Secretary. Whether the names on the ticket, the distinguished presidential candidate, the arguments advanced in his favor, or the facility with which the "Members Ticket" could be voted were equally instrumental in bringing out the ballots, it is certain that an unexpectedly large vote was polled, the total being 467, out of a membership of 673. Out of this number Professor Houston received 245, and Mr. Lockwood 146, the remainder being scattered among twelve other candidates whose names appeared on the list. With the exception of William Wallace, who was elected a vice-president, the names of the other candidates appeared on both tickets, and were elected as follows: P. B. Delany and H. Ward Leonard, Vice-Presidents; Harris J. Ryan, Charles Hewitt, J. J. Carty and W. J. Hammer, Managers, and Geo. M. Phelps, Treasurer.

The members availed themselves very generally of the opportunity for selecting any name on the "General Proposal List," but as usually proves to be the case in practice the privilege was of no value, as the votes were so scattered as to be practically lost.

Experience indicates that the membership did not fully appreciate the preliminary balloting for nominations. This affords an opportunity for suggesting suitable candidates whose names might not otherwise have been considered. The bringing forward of names in this manner is more likely to be effective than a ballot cast for a person not selected for a position on a prepared ticket. A revision of the new system has already been agitated, and the old committee has been reappointed to consider the advisability of amending the rule, which, in some particulars, permitted different interpretations not apparent until it was actually put into practice.

* * *

CONSTRUCTION DEPARTMENT

A & B RAILROAD COMPANY.

_____ Extension. _____ Branch.

Weekly Report of Surveys for week ending, _____ 189

TRANSIT AND LEVEL NOTES

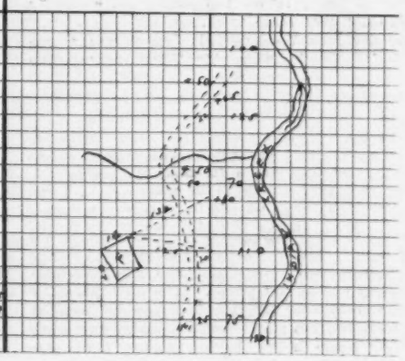
of Location Line L B on James ~~River~~ Creek, ~~Branch~~.

GIVE BELOW FULL DESCRIPTION OF LINE

Sheet No. _____ Engineer _____

| STATION | DISTANCE | DEFLECTION OR ALIGNMENT | CAL. COURSE | MAG. COURSE | GROUND ELEVATION | REMARKS |
|---|---|---|---|---|---|---|
| 125 | 0 | 0 P.C. | | | 321.2 | |
| +50 | | 4 | | | 316.7 | |
| 124 | 0 | 4 | | | 314.1 | Junction Pike |
| +40 | 0 | 4 | | | 311.2 | |
| 123 | 0 | 4 | | | 310.1 | |
| +10 | | 4 | | | 306.4 | Paddleboy Run |
| 122 | 0 | P.C. | | | 309.9 | |

| STATION | LEFT CONTOURS | CENTER ELEVATIONS | RIGHT CONTOURS | REMARKS |
|---|---|---|---|---|
| 20 | | 717.0 | | |
| 19 | | 719.6 | | |
| 18 | | 713.2 | | |
| 17 | 740 735 St. 42 | 714.1 | 690 685 84 41 | |
| 16 | 710 705 700 695 36 30 17 12 | 710.5 | 710 705 700 695 8 12 19 27 | |



FORMS FOR TRANSIT, LEVEL AND TOPOGRAPHY NOTES TO BE SENT TO MAIN OFFICE FOR PLOTTING.

## REPORTS OF TRANSIT, LEVEL AND TOPOGRAPHY NOTES FOR PLOTTING.

Sir: It is oftentimes desirable in running railway lines, either preliminary or location, that the same be kept plotted up as closely as possible. Where this is required, abstracts of the field notes must be made daily, semi-weekly or weekly, or as often as may be deemed expedient or necessary, in order that the field books may be kept in use. Of course, where the draftsman accompanies the field party, two sets of books can be kept, using them alternately. The arrangement breaks the continuity of the notes, and is a reprehensible practice, although used by many engineers.

When the plotting is done at a central office, and at some distance from the field of operation, notes are either copied into record books, and then sent in as soon as filled up, or they are copied on sheets of paper and forwarded at stated periods.

Where the latter practice obtains, blanks especially prepared serve a useful purpose, and are also a great economizer of time. I inclose herewith samples of blanks of this kind used on the ———— Railroad. They are intended for either preliminary or location lines. One of them is for the transit and level notes, the other for the topography notes. Both sheets are 8½ × 14 ins. in size, folding to 3½ × 8½ ins. On the transit and level notes sheet, the headings of the columns are respectively: Station, distance, deflection or alinement, calculated course, magnetic course, ground elevation and remarks.

The transitman is the first one to copy his notes, entering them so as to read from the bottom to the top of the page. The usual practice is to use every fourth line for the full stations, or where the ground is very much broken, it would be better to use only every fifth or sixth line. This allows the leveiman sufficient space for his notes, without crowding or interpolating between lines.

You will notice that the distance, cal. course and mag. course columns seem narrow. This is not the case, as these notes are expected to be written lengthwise the column, in the direction of the top of the page. Sufficient blank space is retained at the top of the page, for full description of the line, which can also be used for giving other useful information of the survey.

The topography sheet is the counterpart of a properly arranged topography book, the topography proper on one page—the right hand one and the left hand page for the contours. By topography it is to be understood to mean the natural and artificial features of the country streams, such as rivers, creeks, runs, etc., roads, houses, etc.

I consider the method of keeping the contour notes an admirable one. The contours are obtained directly in the field by use of a hand level, the elevation of the center line being known, the distance of each contour from the center line being noted, instead of the distances between each separate one. This expedites the plotting. By taking contours at the breaks of the ground, lowest and highest points, equally good, if not better results can be obtained than from sketching in the field, which practice, though theoretically an ideal one, is found to contain many drawbacks and usually necessitates the employment of a draftsman for this work; while on the other hand, a person of ordinary education fills the bill.

Yours truly,

Chicago, Ill., April 25, 1893. Eli Mewol.

(We reproduce the samples sent us, but for the saving of space put the topography notes immediately under the transit and level heading. These headings are alike in both cases, excepting only the designation of the class of notes. As folded for filing each report carries printed on its back a statement of what it is and also the certificate of the examining engineer.—Ed.)

### PILE-DRIVING FORMULA.

Sir: In your issue of May 18, page 462, you describe a case where a pile driven with a 2,900 lb. ram, falling 20 ft., and showing a final penetration of 3 ins., bore 90,000 lbs. for 24 hours without perceptible sinking. It seems a thousand pities that this test was not carried on to the point of perceptible settlement, and also (especially since the pile was in mud), that a trial blow was not given and penetration noted some hours after the driving; but as it stands, it gives another opportunity of comparing the results by your formula:

$$\text{Safe load in pounds} = \frac{2\,w\,h}{s+1}$$

and our own:

$$\text{Extreme load in pounds} = \frac{50\,w \quad \sqrt{h}}{s+1}$$

and it may be well to place it on record as such.

w = weight of hammer, in pounds.
h = height of fall, in feet.
s = final penetration, in inches.

| | |
|---|---|
| Load sustained without perceptible settlement | 90,000 lbs. |
| Safe load by Engineering News formula | 29,000 lbs. |
| Extreme load, Trautwine formula | 98,400 lbs. |

"But lest it might be hastily concluded, from this comparison, that the formulas here give loads far too small, it is but proper to observe that for all we know the pile may have been only just this side of the point of yielding under its 90,000 lb. load. If so, and if from 3 to 4 may be taken as a proper factor of safety under the circumstances, the showing is a very good one for both formulas. John C. Trautwine, Jr.

Philadelphia, May 20.

### NOTES AND QUERIES.

G. H., of New York, asks, "Is there any company in this country ready to operate street cars by compressed air, guaranteeing continuous operation, the question of economy not being important?"

(The Rand Drill Co., of New York, is interested in the introduction of the Mekarski system, described in our columns. Mr. Jas. F. Lewis is President of the Mekarski Company.)

### NOTES IN CHICAGO.

The rapid increase in the use of steel castings and the demand for high-grade metal in such castings make the new steel plant of the Sargent Co., at Fifty-ninth and Wallace Sts. of especial interest. This firm, which is the successor to the Congdow Brakeshoe Co., continues the manufacture of the tire-dressing brakeshoes which gave that company its wide and enviable reputation, and in addition has established a well equipped plant for general iron and steel foundry work. The plant is supplied with two cupolas, one open-hearth furnace and one crucible furnace, and it is the intention of the managers to put as good steel in their castings as can be produced. To put its work to the proof it has a 1,000-lb. drop set up; and the recent competitive tests of M. C. B. couplers were made upon it. A Riehle testing machine of 300,000 lbs. capacity is also being placed in position, and is equipped with special attachments for making pulling tests of couplers. When the machinery now being set up is ready to run the works can turn out over 100 M. C. B. couplers daily from the steel foundry.

The iron foundry can now turn out about 40 tons of brakeshoes per day when working at full capacity. Tabor molding machines are used in the molding department and do excellent and rapid work. In the steel foundry is an electric job crane, built by the Shaw Co., of Muskegon, Mich. It is especially adapted to heavy foundry work, as the swinging of the crane as well as the hoisting is done by electric power. Electric elevators are also in use in the works and a separate cleaning department which is just being installed is to be run by a 20-HP. Jenney electric motor.

In the engine-room are a Rand air compressor and a Russell engine driving two dynamos. Thus either steam, air or electricity is available for use in the shops. One use to which the air is put is in driving a pneumatic striking tool. This is an implement whose manifold applications and value in saving labor are not yet generally appreciated. One use to which it is put here is in cleaning castings. In cleaning gear wheel teeth especially it proves itself to be a dental engine of great efficiency.

The boilers at the works are fired with oil, and some careful tests have just been made by Mr. Van Alstyne, mechanical engineer of the company, as to the relative economy of oil fuel at its present price of 60 cts. per bbl. and Indiana block coal at $2 per net ton. The tests showed a ratio of 90 to 130 in favor of oil.

The Gates Iron Works.—This firm has a wide reputation through its well-known rotary rock and ore breaker; and the success of this machine has led the firm to undertake the manufacture of a general line of mining machinery, much of it of very heavy pattern. One of the large size rock breakers was illustrated in Engineering News of Feb. 9, 1893. A new pattern of Cornish crushing rolls is just being completed, and some heavy hoisting apparatus is being turned out. In connection with the works is a complete plant for crushing samples of ore and an assaying department for determining their value.

An improved method of attaching the crushing head to the oscillating shaft of the rock breaker has recently been adopted. The crushing head is a chilled casting so hard that no tool will touch it, and it was formerly merely cored out and attached to the shaft by running melted zinc into the opening between the shaft and the head. The zinc, however, would contract somewhat on cooling, and under the enormous pressure to which the head is subjected it would sometimes get a little loose on the shaft. By the new plan staves of soft cast iron are attached to the core and are thus cast on the interior of the head. They are then bored out to a taper, the shaft is turned to the same taper and a good and certain fit between the two is secured. To prevent the head turning on the shaft, the shaft is made octagonal for an inch or two just below the taper fit, and the head is cast octagonal, but somewhat larger. Melted zinc is run into the space between the two and is pened down solid. This method of fastening makes the removal of the head from the shaft much easier than when fastened in the old way.

In erecting conveyors and elevators in connection with crushing plants, some use is made of spiral conveyors, but as a general rule buckets attached to a rubber belt are preferred to any other form of endless chain or belt.

Vulcan Iron Works.—These works are located on the Chicago River, which gives them convenient shipping facilities for heavy work and also is an advantage in building and repairing machinery for tugboats, dredges, etc. Steam pile-driving machinery is one of the works' specialties, and another to which considerable attention is being paid is turning machinery for swing bridges. The turning machinery for a large swing bridge at Portland, Ore., is now under way. The facilities at the works have recently been increased by a number of heavy lathes and boring mills capable of handling very large work.

Excelsior Iron Works.—This firm makes a specialty of dredge building. Mr. Thos. Burgess, the Superintendent of the works, left a position as Master Mechanic of a Western railway, 30 years ago, and since that time 180 dredge plants have been turned out under his supervision. At present the works are pushing to completion machinery to fit out a dredge for the Superior Dredging Co., of Superior, Wis., designed to dig 1,200 to 1,800 cu. yds. daily. The hull of the dredge is being built at shipyards in Superior. The centrifugal pump is now largely used on the lakes for dredging purposes, and both dipper and pump dredges are turned out at the works. It is now generally conceded that any soft material can be handled more cheaply by a pump dredge than by any other machine. Some heavy ball-and-socket joints for the 8-in. cast-iron pipe which the Hygeia Water Co. is laying under the Chicago River to convey Waukesha water to the World's Fair are being made in the shop. The joints with which the pipe was first laid proved not strong enough to stand the heavy pressure.

The Harvey Steel Car Works.—An hour's ride on the main line of the Illinois Central brings one to the new manufacturing town of Harvey, established by Mr. T. W. Harvey, the owner of the Harvey Steel Car Works. Under the superintendence of Mr. J. D. McIlwain, for many years connected with the Grand Trunk Ry., and a prominent member of the M. C. B. Association, these works have been developed into a first-class plant for car manufacture and repair. Four good-sized shops have been put up and are well fitted with work. A large amount of car repairing is being done for the Union Tank Line and the American Cotton Oil Co., also for various railway companies. Some of the Harvey steel cars which have been running on the Chicago, Milwaukee & St. Paul, and were badly jammed in a wreck, were being repaired at the time of the writer's visit. The bent pieces of steel were removed, straightened and put back, and the car was again ready for service. In the new steel cars, designed by Mr. McIlwain, the aim has been to simplify and cheapen the removal of the parts for repairs. Some of these cars of recent design are on exhibition in the Transportation Building at the World's Fair. Among recent special jobs are 25 contractor's dump cars for the Thacher Car & Construction Co., fitted with cylinders and attachments for dumping by compressed air. These are to be used by Ricker, Lee & Co., contractors for Sections D, E and F of the Chicago drainage canal.

Buda Foundry & Machine Co.—This plant was removed to Harvey from Buda, Ill., two years ago, and is located in convenient and well arranged shops. Power is distributed from a central point by rope transmission, the plant being furnished by the Mishawaka, Ind., Wood Pulley Co. The shavings and sawdust from the wood shop are drawn to the boiler-room through piping by an exhaust fan. The works turn out a variety of railroad appliances, including switch stands of various standard patterns, the Middleton car springs, the Bogue & Mills crossing gate, and the Buda hand car with either wood or steel wheels. The wood wheel is generally preferred for northern climates as it is light and durable and runs with less noise and vibration than the steel wheel. In the South, however, the extreme heat makes the wood center wheel short lived and the steel wheel is the one generally used.

The town of Harvey has made rapid progress since it was established, three years ago; and it promises to become an important manufacturing center, especially for firms making railway supplies. There are now 18 manufacturing plants in the town, and a 10-acre tract has just been purchased for two more, the Whiting Car Wheel Co. and the Detroit Foundry Equipment Co.

As a matter of fact all the territory in the southern part of Chicago, and for miles south of the actual city limits, is undergoing rapid development, partly because of its intersection by a multitude of railway lines which afford convenient shipping facilities, partly because good sites for large manufacturing plants can be had at moderate cost, and partly no doubt because of the stimulus which has been given to the South Side by the location of the Columbian Exposition at Jackson Park.

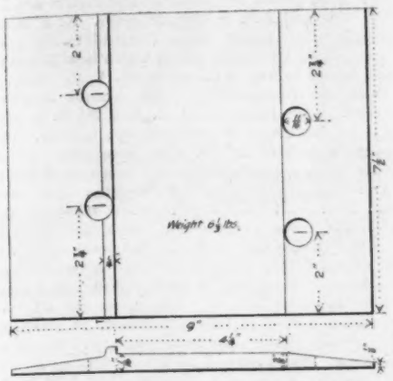
The development of these new manufacturing suburbs is being greatly aided by the construction of a network of electric railway lines. The Calumet Electric Street Ry. Co. is just finishing 104 miles of track in the Calumet district, reaching South Chicago, West Pullman, Burnside and Grand Crossing, and by a northern spur delivering its passengers directly at Jackson Park, thus furnishing easy access to the World's Fair from all this wide stretch of territory. Mr. C. E. Loss, of Chicago, was the original promoter of this enterprise, and the contractor for the roadbed and track of the whole line. The road is laid with Johnson and Wharton 78-lb. girder rails on oak ties. The joints are made with a six-bolt splice-bar held with 1¾-in. bolts. In connection with this enterprise the Pullman Street Railway, which was partially built some years ago, but has never been operated, is to be completed. It is stated that it is to be operated by a compressed air storage system.

### WROUGHT IRON TIE-PLATES; SOUTHERN PACIFIC RY.

The use of metal tie-plates to prevent the cutting of ties by the rail base is becoming more and more extensive in this country, as their use effects a decided economy in maintenance of way and adds to the permanence and security of the track. Several forms of tie-plates have been illustrated and described in our columns, and we illustrate this week the form of plate used by the Southern Pacific Ry. on its Pacific Coast lines, and which has been made for some time at the company's shops at Sacramento, Cal. We are indebted to Mr. Wm. Mahl, Assistant to the President, for the prints from which our cut is made.

The plates are flat on the bottom, as ribs on the under side are found to occasionally split the red-

wood ties, which are soft, although the ribs are an advantage on ties of hard wood. A rib on the upper side takes the lateral outward thrust of the rail and relieves the spikes of the shearing strain. The round holes are made to fit the screw spikes which are used, as with ordinary spikes in the soft red-

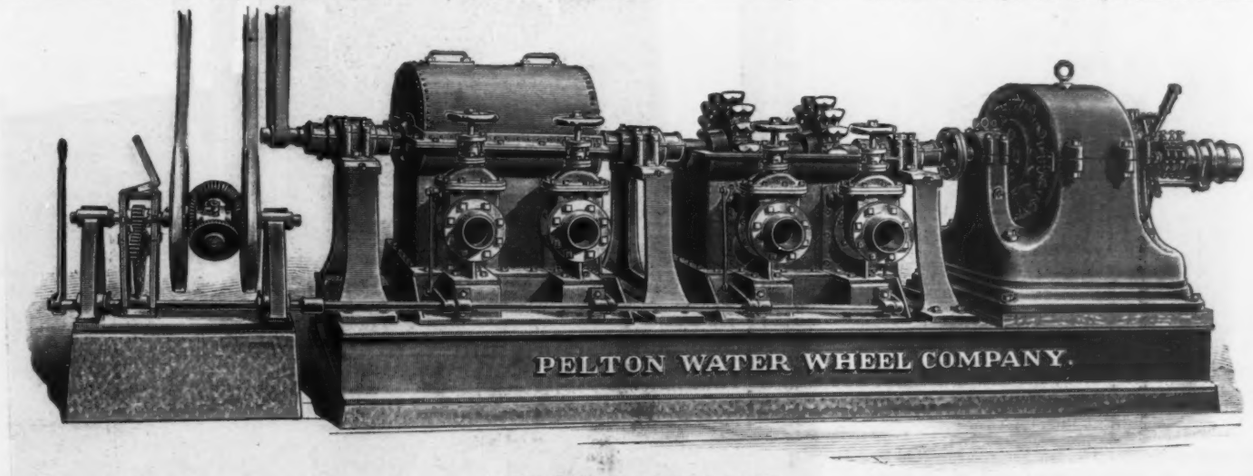



Wrought Iron Tie Plate; Southern Pacific Ry.

wood ties it has been found difficult to hold the rail firmly to the tie, and the play between the tie and the base of the rail contributes very largely to the wearing and cutting of the timber. The plates weigh 6½ lbs. each.

## WATER POWER ELECTRIC PLANT.

The utilization of water power is becoming more and more general, and the power is being applied to a large number of purposes. The accompanying cut represents the application of Pelton water wheels to electric generators furnishing power for running the mining and milling machinery of the Standard Mining Co., of Bodie, Cal., the power station being located 13 miles from the mines. There are four wheels, mounted on one shaft and directly connected to the generator shaft by an insulated coupling. They are 21 ins. diameter and have a combined capacity of 250 HP., with a speed of 860 revolutions per minute, under a running head of 340 ft. The wheels in the plant were required to be of this small diameter to give proper speed to the generator under the head in this case available. A slower speed generator or a higher head of water would have admitted of larger wheels and consequently a less number to give the same power. The Pelton differential automatic governor, shown on the left of the cut, is designed to insure absolute control, maintaining a uniform speed on the wheel with sudden and wide variations of load.




WATER POWER ELECTRIC PLANT.

## DEPOSITING DREDGED MATERIAL ON THE LAND.

In "Le Genie Civil" of April 8 is an illustrated article describing a method of depositing dredged material on land 1,500 ft. distant and over 40 ft. above the water surface. This plant was devised by Messrs. Bony and Daste, engineers for contractor Vernandon in straightening the channel at the point where the Garonne and Dordogne enter the Gironde River, in France. In this improvement a portion of the island of Cazeau was cut away, and a dike was built with the dredged material cutting off the channel behind the island.

The material was vegetable soil, of varying thickness, 8.2 ft. of pure clay, 5 ft. of stiff blue clay and about 13 ft. of argillaceous sand. The soil and clay were first removed in the dry by leaving a dike between the river and the five pits into which the excavation was divided. This was done by excavators operated from a track running parallel to the river bank.

The second operation was to deepen these five basins to 33.3 ft., below the soil surface by dredges entering the basins at high tide by an opening left in the banks for this purpose and closed by a gate. After the pits were deepened the dike and the separating banks were removed and the navigable channel was then dug. In this later operation the plant was exposed to the movement of the tide; and taken in connection with the height of the fill the lift was as much as 53 ft. at low tide. The material was sent ashore in 14-in. pipes resting upon floats, and was carried from 1,300 to 1,500 ft.

Different machines were devised for handling the different materials encountered. For handling the clay and vegetable soil, with more or less small stones and bowlders, the following plan was devised: Upon an iron barge were placed two horizontal, closed cylinders of 52 cu. m. capacity each, and capable of resisting a pressure of five atmospheres. On top of each cylinder were two domes arranged with doors and shutes for receiving the material dredged up by a bucket-dredge alongside. A smaller dome between these was provided for the escape of the water displaced by the material. At the bottom of each cylinder, and connecting with the shore pipe, was a telescoping tube; the outer tube was firmly attached to the cylinder and the shore-tube; but the inner and smaller tube was provided with a rack on its upper side, operated by a pinion on a small engine situated amidships. This smaller tube entered the cylinder and could be pushed along the entire length of it by means of the rack, and a flattened, shovel-shaped nozzle was attached to it by a flexible joint.

On another barge alongside this one was placed a system of Pourrier pumps, of 750 cu. m. delivery per minute at 150 revolutions. These pumps furnished a water-pressure in the cylinders and forced the material into the telescopic tubes and to the shore. The water entered the cylinder by a flattened nozzle just above the delivery tube, and by the stream delivered the dirt was washed away from the point where the inner pipe entered the cylinder and the friction due to the sand, etc., was reduced. The daily output of this device was as much as 1,800 cu. yds., lifted an average of 42 ft. and delivered on the dike 1,400 ft. away.

The second machine for handling the stiff blue clay, was a modification of the first. The receivers were shaped like pots; or they were cone-like with flattened top and bottom; the pumps were also similar and the general process was the same as before described. The third machine was designed to take up the mud, and finely divided material placed in a barge by the dredges. This was done by a centrifugal pump placed on a second barge, with a hinged suction pipe entering the material. The diameter of the pipe was 16 ins. and the daily output varied from 800 to 1,200 cu. m. lifted 28 ft. and carried 1,300 ft. These machines involved expensive handling of the material; but the service demanded was somewhat peculiar, and they are interesting from this standpoint.

## A NOVELTY IN BLOCK SIGNAL SYSTEMS.

Messrs. W. G. Wattson, Superintendent of the Hudson River Division of the West Shore R. R., and Jos. B. Stewart, Superintendent of Telegraph and Signals on the same road, have placed in operation in the Weehawken tunnel on the West Shore an experimental block signal plant embodying some very novel features. Instead of indicating whether a block is occupied or not by a signal at its entrance, as in ordinary practice, they place incandescent lamps at an even distance apart along the length of the block. These lamps are normally kept lit and thus serve the purpose of lighting the tunnel as well as signaling trains. The rule of operation is simply: "Lights out means danger—stop."

In operation the train, by a track circuit arrangement, lights and extinguishes the lamps as it passes along. Thus, calling A, B, C, D successive blocks, a train passing from block B to block C will extinguish the lights on block B and light those on block A, which have been out while the train was running over block B. When the train crosses from block C to block D, the lamps in B will be relit and those in C will be put out. Thus the train has always a dark block section in its rear. For single-track blocking the train can be made to protect itself both in front and rear. Thus a train entering the block B from A would put out the lights in C and would relight them and extinguish those in D on passing from B to C.

As arranged at the Weehawken tunnel the lamp circuit for each section includes a lamp in the block signal tower at the tunnel portal from which the semaphores are operated. Thus these lamps indicate to the operator the position of a train in the tunnel. By opening a switch he can put out the lamps in any section and stop any train.

The instruments used are of the simplest character. A rail circuit operates a relay which controls a local circuit and moves a switch turning the lights of each section on or off. Three cells of gravity battery are sufficient to work the local circuit which turns the switch.

The advantages claimed for the system apply chiefly to working traffic in crowded and smoky tunnels, where ordinary signals are well nigh impossible to distinguish. The engineer has a continuous visual signal, assuring him of safety. As long as the lamps flash past him at regular intervals he is all right. When he fails to see them, it means danger.

Two patents have been allowed covering Messrs.

Wattson and Stewart's invention; some of the claims are as follows:

1. In a system of railway signals for tunnels, the combination, with the various sections or blocks, of a series of lights, extending throughout each section and normally lighted, and electric circuits controlling each series of lights and connected with the respective blocks so that the passage of a train upon any block will automatically extinguish the lights of the preceding block, substantially as described.

2. In an automatic system of signals for railway tunnels, the combination, with the various sections or blocks, of a series of lights arranged along the blocks and normally lighted, a controlling magnet for each series of lights, having a local circuit, and a relay connected to each section of track and controlling the local circuit, whereby the passage of a train on any section or block will automatically extinguish the lights on the next preceding section, substantially as described.

It will be noticed that the system we have described conforms to the cardinal principle that any defect or failure to operate will give the danger signal. Any accident to lights, circuits or other apparatus puts out the lamps, and this is equivalent to an order to stop. The question may arise in the minds of some whether the mere absence of a signal is as effective a stop order as the display of an actual danger signal. Of course the rules are that the absence of a signal always means danger; but in practice, an engineer may lay his failure to see the signal to a mistake in its location or to a moment's weakness of his eyes, and go ahead. If only one signal were displayed at a block entrance, undeniably something plain and positive should be there when the order is, Stop. But it may well be argued that the sudden darkness after passing lamps at one or two-second intervals is as positive a danger signal as can be devised.

## ELECTRIC DRILLS IN QUARRY WORK.

The Solvay Process Co., of Syracuse, N. Y., has had three electric reciprocating drills at work at its limestone quarry near Syracuse since February, and we understand they have given excellent results. The drills are run regularly ten hours per day, putting down holes 6 to 10 ft. in depth and 2 to 2½ ins. diameter at the top. The three drills

The General Electric Company's Electric Reciprocating Rock Drill, Type E.

make from 45 to 75 ft. in ten hours, averaging 50 ft. per day, or 1,500 ft. per month of 30 days. The drills used are the General Electric Co.'s "type E" drill, shown in the accompanying illustration. They are operated at a distance from the power station averaging about 2,000 ft. The transmitting circuit consists of three lines of bare No. 0 copper wire, and in one direction the circuit extends nearly 3,500 ft. from the power station. The generator which furnishes the current is a simple bipolar dynamo fitted with a device for directing the current alternately into the upper and lower coils of the drill. The potential used is 240 to 250 volts. The generator is driven by a 9×12-in. "Straight Line" engine using steam at 90 lbs. pressure. The rock is conveyed from the quarry to the works by a wire rope tramway, and the coal for use under the boiler is brought back on the return line of the tramway.

The type E drill is 49 ins. long over all, and the tube containing the coils is 7½ ins. in diameter. The drill rod has 5 to 7 ins. reciprocating movement and strikes 380 blows per minute. The drill is stopped and started by merely turning a handle which makes or breaks the electric contact between the wire from the generator and the coils of the drill. We are informed that no repairs whatever have thus far been required.

It is claimed as an advantage for these drills that no interruption is caused in their use by even the coldest weather. With steam drills, on the other hand, the distance to which the drill can be operated from the boiler is very small, and with compressed air there is a material loss in efficiency in very cold weather and there is apt to be more or less trouble with the freezing up of the exhaust.

## VARIATION OF THE COEFFICIENT FRICTION WITH DIFFEERENT LOADS AND BEARING METALS.

By Joseph Kuhn and Robert T. Mickle (Graduating Thesis awarded Third Prize in Engineering News Competition of 1892.

(Concluded from p. 471.)

Part II. Description of Machine and Tests.—In the machine to be described, the idea of measuring the friction moment is that of Denton. The method of applying and measuring the load is also taken from Denton's machine, with the modification to be shown. The accompanying engravings, Figs. 6 and 7, show its construction.* At one end of the horizontal shaft A is a cone pulley used to vary the speeds, and at the other is a revolution counter B. Three collars—C, of cast iron; D. of steel; and E, of wrought iron—are keyed on the shaft and are the surfaces on which the bearings to be tested are placed. The collars are 1¾ ins. wide and 2 ft. in circumference. At F is the sample to be tested. It is fastened to the scale beam, G, by two bolts, one of which is drilled from end to end to hold a thermometer, V, by means of which the temperature of the bearing is ascertained. Scale beam G is 5 ft. long, 2½ ft. on each side of the center line of the test bearing. Two weights, I, I, of 20 lbs. each were used on each scale beam, the lever arm being measured by means of steel scales, divided to hundredths of an inch, and fastened to the beam. When these are not sufficient, extra weights (not shown) are placed at the end of the scale beams. The scale beam was of wrought iron, in the form of an inverted truss, as shown in the figure, to withstand the heavy loads liable to come upon it. Just under the strut of the truss a steel plate was fastened. A small pin J, fastened to the same strut, engaged with slotted pieces of iron fastened to a rod, which rod was given a reciprocating motion of about 3-16 in. by

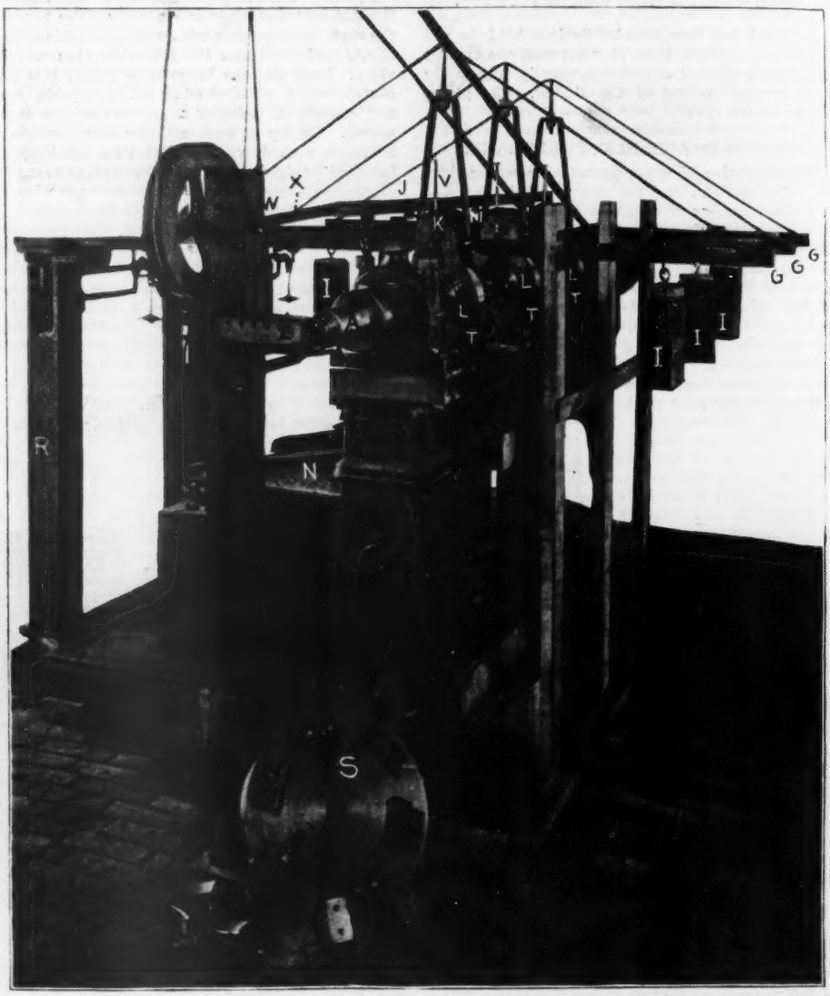



FIG. 6 MACHINE FOR EXPERIMENTING ON FRICTION, DESIGNED AND CONSTRUCTED BY MESSRS. JOSEPH KUHN AND ROBERT T. MICKLE, SIBLEY COLLEGE, CORNELL UNIVERSITY.

means of a connecting rod, X, and crank, W, driven by a round belt from the line shaft overhead. The rate of reciprocation was 26 per minute. Stops were provided to prevent too much vibration of the scale beam. In a groove cut in the steel plate mentioned above, a knife edge, K, was placed, and shackles L, L, were hung from its ends. These shackles extending around the shaft supported by a knife edge M one end of lever N. The load was applied through these knife edges. A second set of knife edges Y supported shackles O so that by screwing down nut P a load could be brought on

*Prof. R. C. Carpenter, of the Department of Experimental Engineering at Sibley College, informs us that the machine described and illustrated, and on which the tests hereinafter described were made, was designed and constructed by the authors of the thesis, Messrs. Kuhn and Mickle, with the exception of the boxes and wearing surfaces, which were designed by himself. The authors of the thesis would have carried their experiments with the machine further, had not its construction occupied so much of their available time.

the lever N. The other end of the lever was supported on a third set of knife edges Q, which in turn were on a pair of scales R. The scales were used to measure the load supplied to the test bearings.

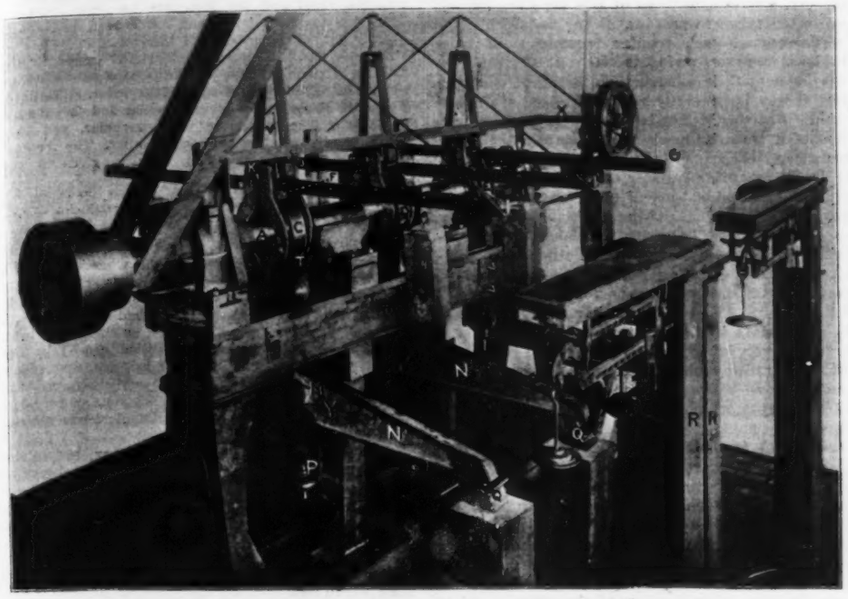



FIG. 7. SIDE VIEW OF FRICTION TESTING MACHINE.

The main shaft was supported in four large babbitted bearings attached to a lathe bed, one bearing on each side of each collar.

In form, the testpieces were similar to a rectangular parallel-piped, 2 13-16 ins. long, 1.42 ins. wide, and having a projected area of 4 sq. ins. One side was planed, drilled by a templet, and tapped to fit the screws which held it in the scale beam G. The same holes were used in fastening

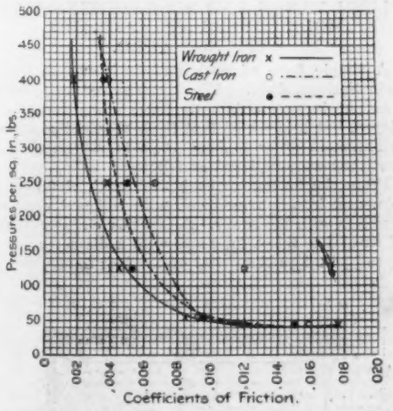



Fig. 8. Diagram Showing Variation of the Coefficient of Friction with Changes of Pressure.

the pieces to small angle plates, which themselves were fastened to a face plate S (see Figs. 6 and 7) fitted to a lathe. They were bored on this face plate, six at once, and then scraped to a good bearing upon the collars. The testpieces were 1 in. thick at their thinnest part.

To avoid any errors due to applying the load eccentrically, the countershaft was fitted with open end cross belts for reversing the direction of rotation. A discussion of the method of eliminating the error due to eccentric load, is given below.

Suppose the machine revolving in one direction, the observations necessary were: (1), time; (2), total revolutions; (3), temperature of journal; (4), temperature of room; (5), weight of poise at extremity of scale beam (if any is used); (6), weight of sliding poises, and (7), lever arm of sliding poises. Then with the machine reversed the same observations are taken. The number of observations varies with the different loads; the object was to run until the temperature became constant, or until it rose considerably above any found in common practice.

Suppose the load applied eccentrically, it will have a certain moment about the center of the shaft which will act with or against the friction, according to the direction of revolution. When acting with the friction, this moment will increase that on the scale beam. With the motion reversed it will decrease to a like amount. By taking the mean of the amounts thus obtained, the effect of eccentricity of load is eliminated.

In making the runs the scale beams could be very easily balanced and kept so, as could also be done with the scales used to measure the load applied. Bath lubrication was used because more uniform results could be obtained than with any other form. A copper casing T surrounded the collar and contained the oil, enough of which was placed in the bottom of the casing to allow the collar to touch its surface. In running it was found that a good part of the oil would be stopped by the front of the bearing and run back into the casing. This piling up of the oil is a very sure indication that sufficient is present to give the required amount.

Extra lard oil, obtained from the Pennsylvania R. R. Co., and which came up to their specifications (see article by their chemist, Dr. C. B. Dudley, in "Eng. & R. R. Journal," February and March, 1890), was used in all experiments. The reasons for using lard oil and that alone through all the experiments, were: (1) Its common use, and (2) the experiments being upon the relative friction of alloys, required that one kind of lubricant be used.

The method of working up the results was as follows: Readings of the temperatures were taken at a point in the data, marked x, where they were nearly the same, and the moments of the small poises were nearly constant for those temperatures. One of the poises was, for convenience, kept in

Table I.—Results from Tests of Sample A.

| Press're per sq. in. lbs. | Wro't Iron Col'r. Vel'city ft. per min. | Wro't Iron Col'r. Temp. deg. Fahr. | Wro't Iron Col'r. Coefficient of friction | Steel Collar. Veloc'y, ft. per min. | Steel Collar. Temp. deg. Fahr. | Steel Collar. Coefficient of friction. | Cast Iron Collar. Veloc'y, ft. per min. | Cast Iron Collar. Temp. deg. Fahr. | Cast Iron Collar. Coefficient of friction. |
|---|---|---|---|---|---|---|---|---|---|
| 25. | 246 | 76. | .0176 | 246 | 75.5 | .0151 | 246 | 77.8 | .0159 |
| | 503 | 89. | .0199 | 503 | 88.0 | .0181 | 503 | 91.5 | .0179 |
| | 1006 | 127.5 | .0.04 | 1006 | 112.8 | .0256 | 1006 | 115.8 | .0173 |
| 65. | 230 | 85.3 | .0085 | 230 | 83.8 | .0095 | 230 | 84.5 | .0092 |
| | 483 | 102.1 | .0112 | 483 | 96.9 | .0076 | 483 | 103.0 | .0103 |
| | 968 | 136.0 | .0122 | 968 | 123.6 | .0107 | 968 | 129.3 | .0157 |
| 125. | 222 | 89.3 | .0044 | 222 | 87.3 | .0054 | 222 | 92.6 | .0120 |
| | 451 | 100.9 | .0074 | 451 | 94.1 | .0085 | 451 | 100.8 | .0078 |
| | 865 | 137.3 | .0092 | 865 | 133.8 | .0018 | 865 | 133.5 | .0082 |
| 250. | 247 | 86.6 | .0038 | 247 | 87.0 | .0 50 | 247 | 89.8 | .0057 |
| | 500 | 105.4 | .0025 | 500 | 107.9 | .0042 | 500 | 104.8 | .0040 |
| | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 400. | 234 | 91.5 | .0018 | 234 | 94.0 | .0035 | 234 | 92.1 | .0038 |
| | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| | .... | .... | .... | .... | .... | .... | .... | .... | .... |

Table II.—Results of Tests, showing Variations of Coefficient of Friction with Changes of Temperature.

| | Kind of Collar. Wro't Iron. Temp. Deg. F. | Wro't Iron. Coef. of Fric. | Steel. Temp. Deg. F. | Steel. Coef. of Fric. | Cast Iron. Temp. Deg. F. | Cast Iron. Coef. of Fric. |
|---|---|---|---|---|---|---|
| Bearing A; pressure per sq. in., 125 lbs., velocity, 451 ft. per min. | 71 | .0102 | 71 | .0131 | 70 | .0139 |
| | 77 | .0061 | 76 | .0106 | 77 | .0114 |
| | 84 | .0053 | 81 | .0086 | 82 | .0101 |
| | 90 | .0060 | 86 | .0076 | 86 | .0107 |
| | 96 | 0.72 | 92 | .0.67 | 91 | .0083 |
| | 102 | .0074 | 97 | .0 58 | 96 | .0088 |
| Bearing A; pressure per sq in., 35 lbs.; velocity, 1006 ft. per min. | 96 | .0376 | 93 | .0281 | 97 | .0356 |
| | 103 | .0282 | 97 | .0238 | 101 | .0374 |
| | 109 | .0211 | 101 | .0241 | 105 | .0252 |
| | 115 | .0239 | 105 | .0204 | 109 | .0194 |
| | 121 | .0247 | 107 | .0279 | 113 | .0.91 |
| | 127 | .0230 | 111 | .0236 | 117 | .0183 |

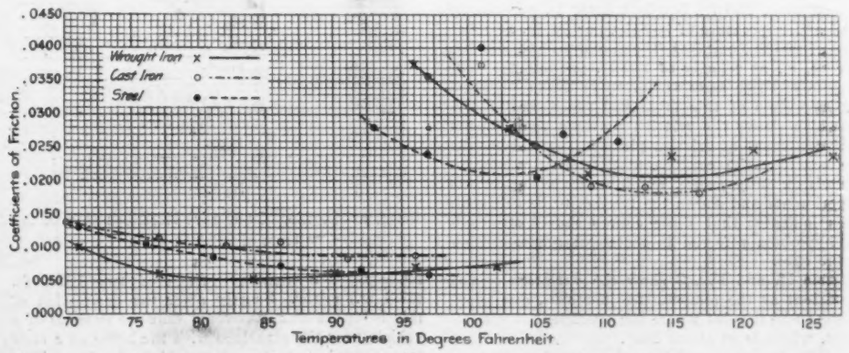



FIG. 9. DIAGRAMS SHOWING VARIATION OF THE CO-EFFICIENT OF FRICTION WITH CHANGES OF TEMPERATURE.

Plotted from Table II. Upper curves for pressure of 35 lbs. per sq. in., and velocity of 1,006 ft. per min. Lower curves for pressure of 125 lbs. per sq. in., and velocity of 451 ft. per min.

Table III.—Comparative Tests of Bearing Metals Under Pressure of 250 lbs. per sq. in. and Speed of 500 ft. per Min.

| Bearing. | Wrought iron collar. Velocity, ft. per min. | Temp. | Wear in milligrams per 10,000 ft. traveled. | Friction per sq. in. of bearing. | Coefficient of friction. | Steel collar. Velocity, ft. per min. | Temp. | Wear in milligrams per 10,000 ft. traveled. | Friction per sq. in. of bearing. | Coefficient of friction. | Cast iron collar. Velocity, ft. per min. | Temp. | Wear in milligrams per 10,000 ft. traveled. | Friction per sq. in. of bearing. | Coefficient of friction. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A | 500 | 105.4 | 33.4 | .6355 | .0025 | 500 | 107.9 | 41.2 | 1.0678 | .0042 | 500 | 104.8 | 22.5 | 1.6049 | .0040 |
| B | 475 | 117.8 | 51.7 | 1.0004 | .0040 | 475 | 125.8 | 47.1 | 1.5190 | .0031 | 475 | 121.0 | 35.2 | 1.4741 | .0069 |
| C | 478 | 170.5 | 29.8 | 1.3817 | .0055 | 478 | 113.5 | 29.5 | .9977 | .0040 | 478 | 122.4 | 54.9 | 2.2369 | .0091 |
| D | 458 | 113.0 | 43.5 | 1.4111 | .0056 | 458 | 117.8 | 68.7 | 1.2231 | .0049 | 458 | 127.8 | 35 0 | 1.7623 | .0070 |
| E | 473 | 113.1 | 49.5 | 1.3092 | .0055 | 473 | 113.1 | 31.4 | 1.3063 | .0052 | 473 | 116.1 | 9.9 | 1.8409 | .0074 |
| H | 468 | 111.1 | 7.7 | 1.0829 | .0043 | 468 | 112.6 | 25.9 | 1.1268 | .0045 | 468 | 116.1 | 16.6 | 1.6614 | .0066 |
| I | 500 | 115.0 | 25.7 | 1.0746 | .0043 | 500 | 117.3 | 32.1 | .9565 | .0038 | 500 | 120.1 | 13.9 | 1.0629 | .004 |

a constant position for all the runs and the other was adjusted. Let $x+z$ represent the arm of small poise (weight, 20 lbs.), where z is the distance from the center of the scale beam to the end of scale, and x the reading on the scale. Let $x^1+z$ represent the arm when the machine is running in the reverse direction. Also let $y+v$ represent the arm of the small fixed poise (weight, 20 lbs.), v representing the distance from the center of the scale beam to the end of the scale and y the reading on the scale. Call the radius of collar $r_1$, and let f represent the friction. If we take moments about the center of the shaft, we have the following equations: $fr+20x+20z-20y-20v=0$ for clockwise rotation, and $-fr+20x^1+20z-20y-20v=0$ for anti-clockwise rotation. Subtracting, we eliminate y, z and v and have $2fr-20(x-x^1)=0$.

Since this is the sum of the moments when running in both directions, we have for the mean moment the half of this, or $fr=10(x^1-x)$. r is known and x and $x^1$ are also known since they are read from the scales, and solving for f we get the friction. This divided by 4 gives the friction per sq. in., and this divided by the pressure per sq. in. gives the coefficient of friction.

Seven samples were tested. Their compositions were:

| | Percentages: | | | | |
|---|---|---|---|---|---|
| Sample. | Copper. | Tin. | Lead. | Zinc. | Phosphorus. |
| A..... | 79.70 | 10 | 9.50 | .... | .80 |
| B ..... | 74.90 | 9.40 | 9.45 | 5.45 | .80 |
| C ..... | 78.45 | 9.80 | 11.75 | .... | .... |
| D..... ... | 74.90 | 9.30 | 11.15 | 5.35 | .... |
| E..... | 87.50 | 12.50 | ..... | .... | .... |
| H.... ... | 85.71 | 14.29 | ..... | .... | .... |
| I ..... | 83.34 | 16.66 | ..... | .... | .... |

Sample A is the Pennsylvania R. R. Co.'s standard phosphor-bronze mixture. Sample B is the same as sample A with 6% of zinc added. Sample C is the Baltimore & Ohio R. R. Co.'s standard bearing metal, and sample D is the same alloy as sample C with 6⅝% of zinc added. Samples E, H and I are alloys of copper and tin in the proportion of 7 to 1, 6 to 1 and 5 to 1, respectively.

Tests were made of sample A under pressures of 35 lbs., 65 lbs., and 125 lbs. per sq. in. at velocities of about 250 ft., 500 and 1,000 ft. per minute and under pressure of 250 lbs. per sq. in. at velocties of 250 ft., and 500 ft. per minute and 400 lbs. per sq. in. at velocity of 250 ft. per minute. The results of these tests are given in Table I. From an inspection of this table and the diagram, Fig. 8, which shows the relation between the pressure and coefficient of friction plotted from this table, we see that the coefficient of friction varies inversely as the pressure, which agrees with previous experiments and shows the friction to be constant. This indicates that these curves should approach an hyperbola referred to rectangular axes, which is the case.

Table II. and Fig. 9 show the variation of the coefficient as the temperature increases, and there seems to be a point where the coefficient is a minimum, which is at about 100°.

It will also be noticed from the runs that the temperature was highest on the cast-iron collar and lowest on the wrought-iron. The steel collar was at an intermediate temperature, but nearer that of wrought iron.

A comparative test was made on samples A, B, C, D, E, H and I under constant pressure and speed, the pressure being 250 lbs. per sq. in., and the speed about 500 ft. per minute. This test was to find the relative temperatures, coefficient of friction and wear. The results are given in Table III. It seems from the results that the effect of adding the 6% of zinc to both the Pennsylvania and the Baltimore & Ohio standards increases the temperature at which the bearing ran. Likewise the effect of the addition of the zinc was to increase both the wear and friction.

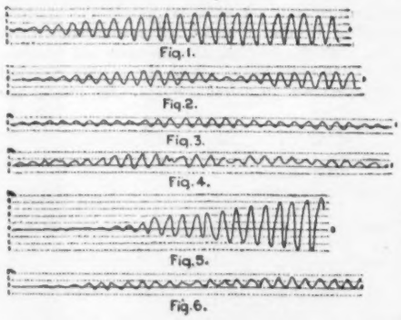
Generally sample A appears to run at a lower temperature than any of the others, and also has a lower coefficient. The coefficient for cast iron was nearly always highest, steel next and wrought iron lowest of the three.

E, H and I, the copper tin alloys, vary somewhat as regards the coefficient, I being the lowest, H next, and then E. This being inversely as the percentages of copper, seems to indicate that with an increased ductility (greater percentage of copper) there is a corresponding decrease of the coefficient.

## CUMULATIVE VIBRATIONS IN BRIDGE TRUSSES.

That injurious and sometimes disastrous vibrations may be produced in suspension bridges by continued light, rhythmic shocks, such as the regular tramp of marching infantry, is well known by engineers, and in structures of this type precautions are often taken to prevent, as far as possible, the occurrence of such regular impulses. In truss bridges, however, owing to the radically different character of their construction, the effect of rhythmic shocks is generally regarded as of small moment. Practically this is true. The vibratory action of a truss bridge is approximately that of a beam, and consequently varies with all variations in length, mass and center of gravity. The probability of the coincidence of the vibratory period of any particular bridge and the rhythmic shocks likely to act upon it is quite small, although under certain conditions this may occur, resulting in cumulative vibrations of considerable intensity. This fact was very satisfactorily brought out by Mr. S. W. Robinson, M. Am. Soc. C. E., in a paper presented to the Society in 1887, describing a series of experiments made by him to determine vibratory effects of railway trains upon truss bridges of various designs. The conclusions reached were that with suitable train speed the primary conditions favoring cumulative vibration were: (1), Non-balance of locomotive driving wheels and (2) yielding stringers, with equality of panel and half-car lengths. It also appeared, as far as the experiments showed, that trusses with both upper and lower chords, like the Pratt, Post and Howe, are more susceptible to vibration than trusses like the Fink and Bollman. As noted, these experiments were made upon railway bridges only.

In the December number of the "Annales des Ponts et Chaussees," M. Deslaudres describes some interesting experiments of a similar character




Diagrams Showing Cumulative Vibrations in a Bridge Truss of 122.3 Ft. Span.

made upon a highway bridge of two 122.3 ft. (37.3 m.) spans. Shortly after the completion of this bridge it was discovered that the passage of a vehicle over the structure with the horse at a slow trot caused a quite appreciable vibration. This led to a more careful examination, during which it was shown that the vibration was caused by the horse alone and not by the vehicle, and finally to a series of careful experiments. These consisted in brief of recording by means of a pencil marking upon a strip of paper having a uniform movement the deflections and vibrations caused by various weights and combinations of horses and vehicles crossing the bridge at different speeds. A large number of diagrams were taken, several of the more characteristic of which are reproduced in the accompanying cut. The conditions under which these diagrams were produced and the author's comments upon them are given as follows:

Diagram No. 1 shows the character of the vibrations produced by the passage of a light vehicle with the horse at a trot; the vehicle weighing 800 kilos. (1,760 lbs.), and the horse 700 kilos. (1,540 lbs.). The maximum half-amplitude of vibration was 2.5 mm., exceeding slightly one half of the deflection due to the regulation rolling load, which was 39,000 kilos. (42.9 tons), and caused a deflection of only 4.8 mm., taking into account the slight vibrations caused by its passage.

Diagram No. 2 demonstrates the importance of rhythmic succession in the shocks. In this case the horse and vehicle passed onto the bridge at a trot; then the horse was made to take several irregular steps by a stroke of the whip, and finally to resume his regular gait and pass off the bridge. It is seen that the impulses of the irregular steps occurred at the ascending phases of the vibration so as to counteract and nearly stop them. Aside from this irregular movement, the gait of the horse was regular and the amplitude of the vibrations increase progressively.

Diagram No. 3 shows the vibrations caused by the same vehicle and horse. This time the gait of the horse was too rapid and the foot-steps too close together. Thus the impulses were not concordant, and consequently the vibrations did not increase.

Diagram No. 4 shows the vibrations caused by the passage of two one-horse vehicles, one closely following the other. Each team weighed 1,500 kilos. (3,300 lbs.). The gaits of the horses were irregular and they did not keep step. The vibrations were irregular, and have the look of conflicting with each other. The diagram clearly shows the discordant impulses given to the bridge.

Diagram No. 5 is that of most interest. It shows the vibrations produced by three one-horse vehicles weighing altogether 4,500 kilos. The impulses given to the bridge by the three horses were quite concordant, and the maximum half-amplitude of the vibration was 4.6 mm., or nearly equal to the deflection produced by the regulation rolling load of 39,000 kilos (42.9 tons). It is seen that the rhythmic shocks have had an effect nearly nine times as great per unit weight as the rolling load.

Diagram No. 6 shows the vibration caused by the same vehicles, but with the impulses not concordant. The impulses have counteracted each other, and the half-amplitude of vibration is but 1.3 mm., or considerably less than that caused by the single horse vehicle as shown in diagram No. 1.

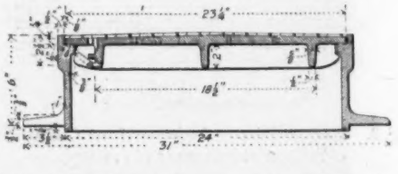
The experiments indicate in a manner not to be doubted the importance of regularity in the shocks to which a truss may be submitted; also, that this regularity is effective only when the vibratory period characteristic of the truss is the same as the period between two successive shocks. When this last condition is realized the regularity of the shocks may have considerable action, as shown in the bridge experimented upon, where comparatively light moving loads have had an effect equal to the heavy load used to test the bridge.

In connection with these experiments the author discusses at considerable length the computation of the vibratory period of bridge trusses and the energy developed by their vibration. As this discussion is largely mathematical and, moreover, of little practical value for the reasons before stated, we shall not enter into it. To those of our mathematical readers who may desire to consider the subject more at length we refer the article itself.

## FLUSH TANKS AND SELF-LOCKING MANHOLE COVERS AT COLORADO SPRINGS, COLO.

A simple form of flush tank is in use at Colorado Springs, Colo. When the sewerage system was put in use, automatic flush tanks were employed, but it is stated that these required so much attention in order to keep them in working order that they were replaced as follows:

From the bottom of each flush tank chamber a 6-in. cast iron quarter bend, with bell end vertical connects with the sewer. A tapering circular block of wood 4 to 6 ins. long and with a diameter from ¼ to ½ in. less than that of the bell flange, fitted




Self-locking Manhole Cover in Use at Colorado Springs, Colo.

with leather to make a tight joint, serves as a stop gate. When it is desired to flush the sewer this gate is removed by means of a chain or rope extending to the surface.

The sewers are 500 ft. apart and parallel, and the flush tanks are in line, so that the whole system, which included 20 miles of sewers in January, 1893, can be flushed in about an hour, it is said. All lines are flushed once, and frequently twice, a day. All dead ends on water mains are connected with the sewers, and in the winter discharge continuously into the sewers.

These flush tanks take the place of the original automatic tanks. In some of the later construction a 4 or 6 in. water main was connected directly with a manhole where flushing is wanted, and the

sewers flushed under direct pressure. In the future the block stopper will be used for flushing, as direct flushing requires too much water.

All manholes and flush tank chambers are provided with self-locking cast iron manhole covers, the details of which are shown by the cross-section. The nose on the right end of the cross-rib, in conjunction with the large arm of the knuckle joint at the left, impinge upon the projections of the frame if the cover is lifted without first raising the large arm of the joint with a key until it clears the corresponding projection in the frame. One key is provided for every 25 covers. The weight of cast iron in one cover and frame is about 150 lbs. The device was invented by H. C. Lowell, C. E., Denver, and is patented.

For a while covers without locks were used, effecting a saving of about $2 per cover, but owing to annoyance from the opening of unlocked covers the lock will again be used in this year's construction.

We are indebted to Mr. H. I. Reid, City Engineer of Colorado Springs, for the information given.

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The new Cape Cod Canal bill passed to a third reading before the Massachusetts Legislature on May 10. This bill is for the project backed by New York capital, pledging $4,000,000 for the completion of the work. A provision of the bill requires the forfeiture of $200,000 unless 75% of the work be completed by June 1, 1898. There were three other petitions before the House, asking for a charter to build a canal across Cape Cod, or the revival of old charters. But these petitions seemed to have little or no financial backing and were not pushed.

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The Harvey Steel Co. of Great Britain has been incorporated, with a capital stock of $950,000, to operate the rights of the Harvey steel process. Mr. Harvey is one of the directors, and furnaces have been erected at the steel works of John Brown & Co., Charles Cammell & Co., and Vickers, Son & Co.

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Red Hook shoal, near Atlantic basin in the East River, New York, is to be removed by the International Dredging Co., Joseph Edwards, President. The amount available for this Government work is $112,000, which, it is believed, will be sufficient to remove half the shoal. The present depth of water is from 7 to 9 ft., and this is to be increased to 24 to 26 ft. at mean low water. The same dredging company will also commence work upon the channels in Gowanus Bay at an early date, under a contract appropriating $178,000 for this work.

## CONSTRUCTION NEWS.

### RAILWAYS.

#### East of Chicago.—Existing Roads.

BALTIMORE & CUMBERLAND.—Work has been commenced near Cumberland where there is a cut 400 ft. long and 30 ft. deep, and it is reported that the force will be increased to 500 men in a few weeks. Four miles from this place there will be a tunnel, then about three miles of heavy work to the river. There will also be a tunnel in Sideling, Hill, Washington Co. Most of the right of way has been secured, and it is proposed to construct the work in sections, although no contracts have yet been awarded. Three routes have been examined for the section between Hancock and Hagerstown, and construction on this will be commenced when the permanent line has been decided upon. W. E. Porter, Supt. of Const., West Virginia Central R. R., has charge of the entire work, and C. Ives, Chambersburg, Pa., has charge of the surveys.

BALTIMORE & OHIO SOUTHWESTERN.—Vice-Pres. W. W. Peabody reports that this road is about to spend $1,000,000 for improved terminal facilities at Cincinnati. Over 1,000,000 cu. yds. of filling are being placed in the Mill Creek bottoms, between Brighton and Cumminsville, to bring this up to grade, and five miles of additional side tracks and an eight-stall engine house will be constructed there. At Brighton additional track room is being provided and the capacity of the freight house doubled. Two additional main tracks will soon be built between Cincinnati and the stock yards, a distance of five miles. This will give a four-track road between these places.

CANADIAN PACIFIC.—It is rumored that this company is taking steps to acquire the Windsor & Annapolis and Western Counties railways, and that a line of fast mail steamers from Yarmouth to Boston will be established.

CLEVELAND, CINCINNATI, CHICAGO & ST. LOUIS.—The $50,000,000 of new mortgage bonds are to be used as follows: $5,000,000 for double track and equipment, $20,000,000 to be reserved for outstanding bonds, and the other $16,000,000 be used only after 1894 at the rate of $1,000,000 per year for double track equipment and construction purposes. Another proposition also voted upon affirmatively gave authority to the directors to extend the line of the Jeffersonville, New Albany & Louisville by constructing new lines, by traffic arrangements with existing companies or by leasing or purchasing lines now built. The controlling interest in one of the bridges at Louisville has been purchased, and it is reported that this is the Louisville and Jeffersonville bridge, which will now be pushed rapidly to completion.

COLUMBUS, LIMA & MILWAUKEE.—It is reported that this road will be constructed between Columbus and Defiance, O., 125 miles, this year. The line has been partly graded from Lima to Defiance, 40 miles, for several years.

DELAWARE, LACKAWANNA & WESTERN.—A press report says that this road will lay 125 miles of steel rails between Buffalo and Bath this summer.

FIRST & SECOND POOL.—Chartered in Pennsylvania to build a railway from Thompson's Run to Mendelssohn, Pa. Pres., Wm. J. Hammond, Pittsburg, Pa.

KEESVILLE, AUSABLE CHASM & LAKE CHAMPLAIN.—The extension from Keesville to Saranac Lake, N. Y., has, it is stated, been fully decided upon. The surveys are nearly completed.

LANCASTER & HAMDEN.—It is stated that the time for completing this Ohio railway has been extended to July 1, 1894. E. P. Buell & Co., Tarlton, O.

LUZERNE, DALLAS & HARVEY LAKE.—This company has been chartered in Pennsylvania to build a railway from Luzerne, Pa., to Dallas and Harvey's Lake, Pa. Pres., John B. Reynolds, Kingston, Pa.

NEW YORK, LAKE ERIE & WESTERN.—This company has decided not to elevate its tracks in Jersey City, N. J., from the river to the tunnel. The company has been considering this work for some time at the request of the citizens, but the cost ($4,850,000) of the work is considered too great.

NEW YORK, NEW HAVEN & HARTFORD.—The abolishing of the grade crossings of the town of Cumberland, R. I., has been under consideration by the council ever since the fatal accident at Lonsdale last winter. Several plans are proposed, one being to construct a bridge to cost about $50,000.

OSCAWANA & CORNELL.—About one mile of the grading has been completed on this line from the Hudson River to the new Cornell dam site. Ch. Engr., Jas. S. Hering, Oscawana, N. Y.

SARANAC LAKE & LAKE PLACID.—Brady Bros. have 700 men at work on this road, and it is reported that trains will be running by July.

SUBURBAN.—This company has been incorporated to build a railway from Morrisville, N. J., through Oxford Valley to Oakford and Germantown, Pa. Pres., Wm. Jenks Fell, 4120 Chester Ave., Philadelphia, Pa.

#### Projects and Surveys.

ATLANTIC & SUPERIOR.—This company has been organized in Canada to build and operate an extensive railway line in opposition to the Canadian Pacific Ry. A press dispatch gives the route as follows: "From the Canadian 'Soo' to Ottawa it will fill in non-completed links of the Ottawa & Parry Sound. From Ottawa to Montreal there will be a new line for which charters have been granted by Parliament, or by acquiring one of existing roads, perhaps the Canada Atlantic. At Montreal it is proposed to bridge the St. Lawrence River at a cost of $5,000,000. Montreal city being expected to grant a bonus of $1,000,000. The road will terminate at a point on the Baie des Chaleurs, the most eastern point of New Brunswick, and if the money is forthcoming a line of steamships will run from and to Europe. From the 'Soo' to Duluth running rights have been acquired, and at Duluth the road will connect with the Northern Pacific or Great Northern, thus completing another transcontinental and transatlantic route. Mr. A. F. Gault, the Canadian cotton king, has gone to London to float the bonds, and Duncan McIntyre, a director of the Grand Trunk, who was at one time deeply interested in the Canadian Pacific Ry., is expected to join the Board of Directors." Pres., J. R. Thebaudeau, Montreal, P. Q.; Secy., C. N. Armstrong.

CAPE MAY.—The projectors of this road to Cape May, N. J., have had surveys made of the proposed route, and have made an offer to the Pennsylvania R. R. Co. for the purchase of the defunct Philadelphia & Seashore R. R. The offer has not been acted upon.

GALLIPOLIS & PORTSMOUTH.—It is stated that Cleveland capitalists propose to build a railway from Gallipolis to Portsmouth, O., 47 miles.

GRAND RIVER & MAHONING.—The final surveys for this road are being made, and the construction will soon begin. The line will extend in a southerly direction from the mouth of Grand River, opposite Fairport, to Steubenville, O., and is intended for an ore and coal road; Pres., Jas. Richie; Vice-Pres., L. O. Rawson; Treas., F. C. Osborn; principal office, Cleveland.

LONG ISLAND CONSTRUCTION CO.—This company has been chartered in New York to construct railways, bridges, tunnels, etc. It is stated that the object of the company is to build the tunnel between Brooklyn and Jersey City, projected by Mr. Austin Corbin. The directors are: Wm. G. Bosworth, Jos. H. Jones, New York, N. Y., and Wm. J. Kelly, Brooklyn, N. Y.

PHILADELPHIA, HONESDALE & ALBANY.—The New York state board of railroad commissioners will give a hearing May 31 on the application of this road for a line from Hancock, on the Pennsylvania line, to Albany, N. Y.

PHILADELPHIA & PITTSBURG.—Wm. J. Wagenknight, Philadelphia, Pa., is president of this company, whose incorporation was noted in our issue of May 11.

TIONESTA VALLEY & SALMON CREEK.—This road has been incorporated to operate between Cross Run railroad bridge to Kellerville, Pa.; capital stock, $50,000; Pres., Truman D. Collins, Nebraska, Pa.

#### Southern.—Existing Roads.

CARRABELLE, TALLAHASSEE & GEORGIA.—Work will soon be resumed on the extension from Sopchoppy to Tallahassee, Fla., 30 miles. Gen. Man. A. O. Symington, Carrabelle, Fla.

GULF & TENNESSEE.—Bids for the construction and equipment of this railway are being received. This company was chartered last December to complete a line from Gulfport, Miss., to Jackson, Tenn., connecting the Gulf & Ship Island and the Gulf & Chicago railways. By a decree in favor of certain creditors of the old Gulf & Ship Island R. R., certain collateral securities will be publicly sold on May 29, and it is expected that the new company will buy them to control the charter which grants valuable privileges, such as exemption from taxation until 1902, grants of land, etc. The new company is composed of Englishmen chiefly. Dr. G. Frederick B. Howard, Jackson, Tenn., is president of the company.

NEWPORT NEWS & MISSISSIPPI VALLEY.—Work between Hodgenville and Scottsville, Ky., 68 miles, will be commenced within 60 days, and the line pushed to completion. Much of the right of way has been secured. The route begins at Hodgenville and extends through Hammonville and Canmer, where it crosses the Green River, thence east of Hardyville through Bearwallow, Glasgow, Payneville and Cedar Springs to Scottsville. The route as proposed from Gallatin, Tenn., across the Cumberland River, and thence to Nashville, has not been determined upon, although it is reported that the road will not only reach Nashville, but will be built to Chattanooga.

WELCH'S MILL & CENTERVILLE.—This road is being built through the pine forest of Central Alabama. The projected length is about 25 miles, of which 20 miles have been surveyed, 12 miles graded, and 11 miles of track laid. The road will be used for lumber and local traffic. The contract for the construction to Oakmulgee Creek, 15 miles, has been awarded to J. A. Foley, Museville, Ala. J. E. Bozeman, Engr. in charge, Selma, Ala.

#### Projects and Surveys.

PANTHER FORK.—This company has been incorporated to build a road from Beans Island, Upshur Co., along the western waters of Middle Fork River and Jenk's Fork of Middle Fork River, in Randolph Co.: A. M. Winchester, J. D. Rowles, C. C. Vanderhoff, all of Buckhannon, W. Va.

#### Northwest.—Existing Roads.

CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA.—Winston Bros., Minneapolis, have sub-let the contract for grading the extension of this road from Ponca to New Castle, Neb., to Stebbins Bros., Smith & Conlin and Jas. Reilly. The work will be commenced as soon as the outfits can be put on the ground. Each sub-contractor is to take a section of the line.

DULUTH, PIERRE & BLACK HILLS.—The right of way has been guaranteed to this road through Aberdeen, S. Dak. J. A. Ward, who owns the grade now completed from Aberdeen to Pierre, says that a large force of men will soon be put at work to complete the extension.

INDIANAPOLIS, DECATUR & SPRINGFIELD.—This road was recently sold at foreclosure sale for $2,410,000, and will be reorganized as the Ravenna & Springfield R. R. Co., recently incorporated for this purpose by M. D. Woodford, Eugene Zimmerman and C. W. Fairbanks, of the Cincinnati, Hamilton & Dayton, and T. B. Atkins and others of the junior security holders' committee. Bonds for $2,000,000 will be issued for additional terminals, modern equipment, and other improvements. The principal and interest are guaranteed by the C., H. & D., which will have jurisdiction over the entire line after the reorganization is completed, although it will be operated as a separate line.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—The grade on this line for 20 miles down the Mouse River valley, south of Minot, N. Dak., is rapidly nearing completion. Piles have been driven for the bridges and culverts, and in about two months tracklaying will be under way.

WINONA, MARSHALLTOWN & SOUTHERN.—Engineers have completed the survey for this road and made a favorable report, and it is reported that immediate steps will be taken for the construction. The projected road is an extension of the Winona & Southwestern from Osage, Ia., through Marshalltown, Charlton, and the coal fields of southwestern Iowa.

#### Projects and Surveys.

ASHLAND BELT LINE.—Thos. Bardon, Ashland, Wis., is chairman of a committee appointed to organize a company to build a belt line within the city of Ashland. The project is reported to refer to the building into the city of the Duluth, South Shore & Atlantic Ry.

IOLA & NORTHERN.—This proposed Wisconsin road will be a connection of the Green Bay, Winona & St. Paul, and will operate through the counties of Waupaca, Portage, Marathon, Lincoln and Price, having a terminal at Prentice on the line of the Minneapolis, St. Paul & Sault Ste. Marie. Work on the line will begin within a few days. The line will be about 100 miles in length. The offices of the company will be located at Green Bay, Wis. Officers: Pres., Joseph Walker, Jr., New York; Vice-Pres., S. W. Champion, Green Bay; Sec. and Treas., W. J. Abrams, Green Bay.

MINNEAPOLIS, ST. PAUL & LAKE SUPERIOR.—Chartered in Minnesota to build a railway from Minneapolis and St. Paul, Minn., to Duluth, Minn. This project has been under consideration for some time, the object being to secure a short line between the points named. Surveys have been made securing a line 136 miles long. The projectors state that the road will be completed by May 1, 1894. The officers are: Pres., Donald Grant, Faribault, Minn.; Vice-Pres., K. D. Chase, Faribault, Minn.; Treas., Wm. Dawson, St. Paul, Minn.; Secy. and Gen. Man., F. H. Anson, Minneapolis.

SAYLOR SPRINGS.—This company, which proposes to build a road from Clay City to Saylor Springs, Ill., has organized at Clay City and elected the following officers: Pres., J. I. McCawley; Vice-Pres. and Treas., L. G. McNair, St. Louis; Secy. and Gen. Man., N. M. Burns. It is reported that work on the line will be commenced at once.

#### Southwest.—Existing Roads.

CURRENT RIVER SOUTHWESTERN.—This Arkansas railway will probably be extended to a point near Mammoth Springs, Ark.

GALVESTON & WESTERN.—The directors of this road, which traverses Galveston Island, a distance of 17 miles, but enjoys franchises for additional territory, have called a meeting of the stockholders for July 12 to act upon a proposition to issue bonds at the rate of $20,000 per mile, for the purpose of extending the road through East Texas.

#### Projects and Surveys.

GULF, BEAUMONT & KANSAS CITY.—The report that arrangements have been made to build 90 miles of this Texas Railway at once is confirmed. The road is being built by the Texas Pine Land Association.

KANSAS CITY & NEW ORLEANS.—W. A. Disborough, Pres. and Gen. Man. San Francisco, is reported as stating that capital has been secured to build this road, and that the Dalby Springs Land & Improvement Co. will be incorporated in Arkansas to construct the line. It is expected to extend the line this year from the St. Louis Southwestern at De-boro to Dalby Springs, Tex. Hugh Stuart, Ch. Engr., Dalby Springs.

#### Rocky Mt. and Pacific.—Existing Roads.

NORTHERN PACIFIC.—It is reported that this road is about to ask for bids for filling a number of bridges

on the Cascade and Pacific divisions.—It is stated that the Gray's Harbor branch will be extended about five miles.

SOUTHERN PACIFIC.—The Los Angeles, Cal., "Express" reports that this company will soon begin the construction of a branch road from Burbank to Chatsworth Park, about 30 miles due west, and at the foot of Simi Pass.—Work was commenced in the gap between Santa Margarita and Ellwood about six months ago, and is being pushed rapidly by about 900 men. Rails are laid to within 10 miles of San Luis Obispo, and local papers report that the road will be completed to Santa Barbara by January, 1894.—During 1892, according to the report of the railroad commissioners, the following lines were added to this system in California: Redlands Junction to Crafton, 7 miles; Collis to Fresno, 15 miles; Fresno to Pollasky, 24 miles; Decleo to Decklexville, 2½ miles; Baden to San Bruno, 4 miles; Santa Monica to Santa Monica wharf, 2½ miles; total, 54 miles. The motor road from San Bernandino to Redlands, and from San Bernardino to Motor Junction, 7 miles, has also been leased.

### Projects and Surveys.

FLORENCE & CRIPPLE CREEK.—Chartered in Colorado to construct a road from Florence to the Cripple Creek district, 40 miles. It is reported that arrangements have been made to commence the construction at once; capital stock, $1,000,000; incorporators, Eben Smith, W. A. Johnson, A. B. Roeder, Geo. E. Ross-Lewin. The company is a reorganization of the Florence, Cripple Creek & State Line R. R. Co.

INDEPENDENCE & SALEM.—Incorporated in Oregon to build a railway from Independence to Salem Bridge, Ore., 10 miles. Incorporators: J. A. Veness, J. M. Vanduyn, R. D. Cooper, J. M. Stark and Phil. Metschan.

MONTEREY & FRESNO.—The president of this road reports that he has negotiated the sale of bonds for the construction of this road, and bonds for $2,000,000 will be issued at once. Construction will be commenced at Monterey, Cal., and final surveys will soon be made. It is expected that the road will reach Salinas by November. The first step will be the construction of a wharf at Monterey. F. P. McCray, San Francisco, is chief engineer.

SAN DIEGO & PHOENIX.—It is reported that engineers have left Phoenix, Ariz., in charge of Hampten Storrey, a director, to survey the preliminary line for this road. It is proposed to have the road completed and ready for traffic by July, 1894.

### Foreign.

ATCHISON, TOPEKA & SANTA FE.—A report from Durango, Mex., says that this road is endeavoring to secure a concession from the Mexican Government for an extension of its line now in operation between Altata and Culiacan, 38 miles. If this is granted the road will be extended to Durango across the Sierra Madre mountains and thence to Salinas.

## ELECTRIC RAILWAYS.

CALAIS, ME.—Geo. A. Curran and C. D. Hill are interested in a proposed line, 5½ miles in length, at this place. It is hoped to have the road completed in July. The electricity will probably be generated by steam power.

ASBURY PARK, N. J.—It is reported that J. C. Shafer, Pres. Seashore Electric Ry. Co., is organizing the Monmouth County Seashore Electric Ry. Co., which will have a paid up capital of $1,500,000, and will begin at once the construction of a trolley road, to extend from Pleasure Bay, near Long Branch, to Point Pleasant, passing through Long Branch, West End, Elberon, Deal Beach, Loch Arbor, North Asbury Park, Asbury Park, Ocean Grove, Key East, Belmar, Spring Lake, Como and Point Pleasant. Three power stations will be established along the proposed route, besides the one at this place, which the new company will purchase.

CAMDEN, N. J.—The West Jersey Traction Co. has been incorporated by W. P. Logan, D. Wistar, Philadelphia, and others; capital stock, $3,000,000.

PHILADELPHIA, PA.—The Old York Road Passenger Ry. Co. has been incorporated to operate an electric road in Germantown Ave. and Old York Road to Broad St.; $15,000; Pres., John A. Rigg.

PITTSBURG, PA.—C. I. McDonald & Co. have been awarded the contract for building the Pittsburg, Neville Island & Coraopolis Electric Ry. The line will begin at McKee's Rocks, the present terminus of the Pittsburg & West End Ry., and extend by Neville Island to Coraopolis, about eight miles.

FREDERICK, MD.—The Frederick & Middletown Valley Passenger Ry. Co. has been incorporated by C. V. S. Levy, Geo. N. Smith and others; $125,000. The preliminary survey for this road is now being made, as stated last week.

JACKSON, MICH.—A franchise for a road in several streets has been granted to W. E. Hayne, Jackson, and W. R. Gravely, New Orleans.

CHICAGO, ILL.—The North Chicago Electric Ry. Co. has been incorporated by Chas. H. Gurney, J. E. Burke and A. M. Savage; $2,000,000.

NEENAH, WIS.—The Menasha & Neenah St. Ry. has been sold to F. S. Shoemaker, Akron, O. The motive power will be changed from horses to electricity.

GREEN BAY, WIS.—The Green Bay Electric St. Ry., now being constructed, will be extended to the new industrial town of Allouez.

OGDEN, UTAH.—It is reported that the incorporation of the Canyon Water & Power Co., noted in another column, will result in the completion of the Henderson-Brinker electric street railway project, which company owns valuable franchises in this city.

RIVERSIDE, CAL.—It is reported that about 15 miles of street railway lines will adopt the trolley.

## ELEVATED RAILWAYS.

CHICAGO, ILL.—The city council has granted the Lake Street Elevated Ry. Co. the right to build six lines of elevated road, the routes being as follows: From the main line of road now constructed between La Salle and Jefferson Sts., in a northerly direction to Fullerton Ave., between Sheffield Ave. and Larabee St., thence in a northwesterly and northerly direction to the city limits; from the road at Market and Lake Sts., in a southerly direction along Market St. to Madison St., north of Fullerton Ave., from between Belmont and Fullerton Aves. westerly to the city limits; from the main line on Lake St., 750 ft. east or west of Halsted St., in a southerly direction to the city limits; from the main line on Lake St., between Hamlin Ave. on the east and West 47st. St. on the west, in a southerly direction to the south line at Madison St.; from the main line on Lake St., between Rockwell on the east and West 47th. St. on the west, in a northerly direction to Diversey St.—The ordinance granting a franchise to the Grand Central Ry. Co. to build a system of elevated lines, referred to in our issue of May 4, is now being considered. The company is to use neither wood nor bituminous coal for fuel, and two miles of road are to be constructed within two years and the remainder within three years from the acceptance of the ordinance.

## HORSE AND MOTOR RAILWAYS.

JERSEY CITY, N. J.—The New Bedford & Fairhaven Traction Co. has been incorporated, to construct and equip street railways in this city and New Bedford, Mass.; $1,000,000; T. M. Walker, New London, Conn.; J. Irvine, New York.—The American R. R. Impt. Co. has been incorporated to deal in street railways in this city and Boston, Mass.; $1,000,000; E. Davis, G. A. Beatey, Hyde Park, Mass.; H. H. Ashley, Springfield, Mass.

NEW ORLEANS, LA.—The city council has voted to advertise the sale of the franchise now operated by the New Orleans City & Lake R. R. Co., for 50 years. The present franchise has 13 years to run, and the early sale of the new franchise is desired to secure funds for proposed improvements, including that of a general drainage system of the city.

OMAHA, NEB.—The East Omaha St. Ry. Co. has been incorporated by John L. Welsh and E. T. Statesbury, Philadelphia; H. W. Yates and others, Omaha; $1,000,000.

## HIGHWAYS.

NEW JERSEY.—The contracts for macadamized roads and for broken stone for road repairs in Bloomfield during the coming year have been awarded to Wright & Lindsley.

KENTUCKY.—The commissioners of the Covington, West Covington and Ludlow public highway will receive bids until June 1 for grading, macadamizing, culverts and masonry. J. S. Weaver, Engr., Ludlow.

OHIO.—The commissioners of Cuyahoga county will receive bids at the court house, Cleveland, until June 12 for grading, draining, and macadamizing or paving with brick three county roads. Jay F. Brown, Co. Engr.

## BRIDGES, TUNNELS AND CANALS.

LEWISTON, ME.—A movement is being made to secure the construction of a new iron bridge over the Androscoggin River.

BOSTON, MASS.—The proposed bridge across the Mystic River, connecting Charleston and Chelsea, will be built of iron, and it is stated that work will begin at once. The total cost of the bridge and viaduct approaches will be $270,000.

LOWELL, MASS.—A bridge over the Concord River at East Merrimac St. is proposed.

WILLIAMSTOWN, MASS.—It has been decided to build a bridge, to cost not exceeding $8,000, over the Hoosac River. Bridge Com., N. H. Sabin, Jas. M. Waterman and Chas. S. Cole.

BRIDGEPORT, CONN.—It is possible that the Washington bridge will be replaced by a new structure, as cheaper than repairing and partly rebuilding the old bridge, as ordered by the War Department. D. H. Rowland, Secy. Bridge Com.

ELLICOTTSVILLE, N. Y.—The town auditors have voted to build an iron bridge at Didcock's.

BATH, N. Y.—The town board has decided to erect a new iron bridge over Cohocton River at the site of the old Spaulding bridge. Estimated cost, $5,500.

OGDENSBURG, N. Y.—Plans have been prepared for both a steel and stone bridge over the Aswegatchie River, by Charles F. Stowell, Albany, N. Y. The estimated costs are: $45,000 and $55,000 to $60,000, respectively.

GLOUCESTER CO., N. J.—At the annual meeting of freeholders it was recommended that $10,000 be raised for bridge work.

HUDSON CO., N. J.—Bids are asked for $100,000 of bridge bonds, bearing 4½% interest.

GETTYSBURG, PA.—Bids will be received until May 31 for a 90-ft. iron bridge. Jos. Holtz, Jos. Redding and John N. Boyer, Co. Commrs.

HOWARD CO., MD.—The Elkridge Bridge Co. proposes to build a bridge over the Patapsco River, connecting Howard and Baltimore counties.

HAMILTON, O.—A bridge will probably be constructed across the lowland opposite the Cincinnati, Hamilton & Dayton R. R. crossing at South Hamilton, O.

ONONDAGA, MICH.—A 130-ft. span iron bridge will be built over the Grand River.

APPLETON, WIS.—The Milwaukee, Lake Shore & Western Ry. will build a bridge over the Fox River; $30,000.

CARTHAGE, MO.—The city attorney has been instructed to draft an ordinance instructing the Missouri Pacific Ry. Co. to replace the wooden bridges over its tracks on Oak and Walnut sts., with iron bridges the full width of the streets.

ST. CHARLES, MO.—There is a movement to build a bridge over the Missouri River.

## WATER-WORKS.

BANGOR, ME.—The water board has voted to lay a 20-in. main from the pumping station into the city.

FITCHBURG, MASS.—The water commissioners have been authorized to construct a dam at Meetinghouse Pond, in Westminster, to cost $15,000.

MELROSE, MASS.—The town has been authorized to use the water of Ell or Crystal Pond, or other waters in the town, or to sink wells to secure an additional supply.

PITTSFIELD, MASS.—The aldermen have appropriated $30,000 to extend the mains to Pontoosuc.

ROCKPORT, MASS.—The Rockport Water Co. has been incorporated by H. N. Woods, C. H. Cleaves and others, and authorized to take water from Cape Pond and Mill Pond brook.

WEST BOYLSTON, MASS.—The town has been authorized to take water from Ball or Trout Brook and Governor's Brook, in Holden, and the waters of any pond or stream in this town.

ROCKVILLE, CONN.—The recently organized Rockville Water & Aqueduct Co., which succeeds the Rockville Aqueduct Co., has elected the following officers: Pres., A. P. Hammond; Treas., J. C. Hammond, Jr.; $125,000. Extensions are talked of.

WATERBURY, CONN.—The city council has adopted plans for a new supply. A dam 80 ft. high is proposed in the towns of Watertown and Thomastown, and a reservoir to cover 30 acres.

IRVINGTON, N. J.—The village trustees have accepted the offer of the Irvington Water Co. Four miles of mains will be laid, one-half of the supply to be furnished by Oct. 1, 1893, and the whole by May 1, 1894.

CHELTENHAM, PA.—Wm. S. Perot, Jr., Jos. S. Koon, Jr., and others will apply for a charter for the Oak Lane Water Co.

McKEE'S ROCKS, PA.—The Monongahela Water Co. has made a proposition for a supply. The citizens think that artesian water can be procured and works put in for $50,000, it is reported.

NANTICOKE, PA.—The Susquehanna Coal Co. is reported as about to increase its supply from 1,000,000 to 2,500,000 gallons daily, by constructing a main to Newport Center, three miles, where a reservoir of 10,000,000 gallons capacity will be constructed.

CUMBERLAND, MD.—May 15 the citizens voted to spend $25,000 for additional pumping machinery. The proposition to spend $20,000 in water-works improvements and to build a reservoir was defeated.

CLARKSBURG, W. VA.—The question of a filter plant will be voted upon June 6.

PIEDMONT, W. VA.—The citizens have voted 312 to 110 in favor of works.

WINSTON, N. C.—An election will be held June 21 to vote on the purchase of works. It is proposed to lay 15 or 16 miles of additional pipe, according to reports.

QUINCY, FLA.—A. L. Wilson, H. W. Scott and H. L. Shaw have been appointed a committee to ascertain the probable cost of mains in the principal streets.

BELLEVUE, O.—The village will build a stand pipe 20×100 ft., buy a new pump and extend the mains; estimated expense, $14,000. Bonds for $12,000 at 5% to run ten or more years will be sold. Jno. Laylin, Vil. Clk.

DAYTON, O.—The water-works board will receive bids until June 20 for a pumping engine, as stated in our advertising columns. John W. Hill, Cincinnati, has been engaged to remodel the water-works and fire protection system of the Southern Ohio Asylum for the Insane. The work will include an ornamental water tower.

GREENVILLE, O.—Works will be completed and in service about Sept. 1. John W. Hill, Consult. Engr., Cincinnati.

NAPOLEON, O.—Bids are asked until June 20 for works, as stated in our advertising columns. J. B. Strawn, Engr.

ORRVILLE, O.—Alexander Potter, New York, has been engaged to prepare plans for works.

READING, O.—The contract for pumps, boilers, etc., for the new works has been awarded to the Laidlaw-Dunn-Gordon Co., Cincinnati.

SHREVE, O.—Julius Eberhardt, Engr., is preparing plans and specifications for works.

LA GRANGE, IND.—Bids are asked until June 8 for works, as stated in our advertising columns.

ROCHESTER, IND.—The contract for 80 hydrants and the valves required for the new works has been awarded to the Crane Co., Chicago.

CHEBOYGAN, MICH.—Chas. F. Loweth, St. Paul, has been engaged as consulting engineer for a new supply and extensions.

MACKINAW CITY, MICH.—Works are being discussed. Chas. F. Loweth, Engr., St. Paul.

AUSTIN, ILL.—The town clerk of Cicero is advertising in another column for bids for works.

GALESBURG, ILL.—The city engineer has reported plans for the construction of a reservoir of 3,000,000 to 7,000,000 gallons' capacity, at an estimated cost of $7,419 to $26,133, according to plan accepted.

OTTAWA, ILL.—At a recent meeting of prominent citizens, it was decided to secure a supply from artesian wells and to build works to cost about $150,000. A private company supplies a portion of the city.

LAKE CITY, IA.—The contract for works has been awarded to A. F. Paige, Sioux City, at about $10,000.

MOUNT VERNON, IA.—W. E. Sheldon, Cedar Rapids, has been consulted by the city with regard to works; proposed supply, wells; estimated cost, $8,000.

LAKE CITY, MINN.—Bids will be received until June 13 for the construction of works, including 13,896 ft. of 16 to 4-in. cast iron pipe, water tower and pumping plant. H. A. Young, Mayor.

KIRKWOOD, MO.—A franchise has been granted to L. G. Burr & Co.

ST. LOUIS, MO.—The board of public improvements will receive bids until June 13 for excavating, laying iron pipe, etc.

GALVESTON, TEX.—W. Kiersted, Ch. Engr., informs us that the contract for the construction of the new supply has been awarded to J. W. Byrnes & Co., Galveston, at $785,992, divided as follows: Laying 30-in. pipe on land in trench, in bay and across channel, 300 tons flexible joints, 60 tons specials, lead, reservoir, all valves, bridge, 36-in. iron pipe and connecting same to wells, $645,992; guaranteeing 5,000,000 gallons of water per 24 hours, $140,000; estimated number of wells, 33; $3,000 to be deducted for each well less than 33; contract to be completed within 12 months in all details except production of water, and city to be furnished sufficient supply until full amount of 5,000,000 is produced.

SILVER PLUME, COLO.—The water-works committee has been instructed to locate a supply and to employ an engineer to make surveys and estimates. The Silver Plume Water Co. offers to sell its rights for $500.

LATAH, WASH.—The town will have a supply from artesian wells, it is reported.

ROSLYN, WASH.—A daily supply of 34,000 gallons has been secured from an artesian well. The well will be connected with the main.

WALLA WALLA, WASH.—The council has authorized the appointing of an engineer to make surveys and estimates for a new system.

CORVALLIS, ORE.—The council has adopted the plans and specifications of J. G. Kelly, Cy. Engr., for works. The plans include a 500,000-gallon reservoir; estimated cost, $23,134.

FOREST DALE, UTAH.—A company has been incorporated with a capital of $50,000 to construct works; Pres., Geo. M. Cannon. Water will be taken from springs about 3,000 ft. distant, and at an elevation of about 80 ft., where there is already a reservoir. The construction will be commenced at once, the following cast iron pipe to be used: 10-in., 100 ft.; 8-in., 100 ft.; 6-in., 2,800 ft.; 4-in., 5,000 to 7,000 ft.; 3-in., 3,000 to 4,000 ft.

FORT WILLIAM, ONT.—We are informed by I. D. Mackay, Town Engr., that the town is making surveys for a complete system.

TORONTO, ONT.—Offers have been received from four companies for a supply of water. The works are owned by the city.

### ARTESIAN WELLS.

MOLINE, ILL.—It is reported that a supply of artesian water will be secured. The present supply is of river water.

EL PASO, TEX.—The city council will sell bonds for $25,000 on June 2, to secure funds for boring an artesian well.

### IRRIGATION.

DENVER, COLO.—Bids are asked until June 12 for the completion of state canal No. 1, about 75 miles in length. H. C. Childs, Secy., Equitable Bldg.

PORT FALLS, WASH.—Dr. N. G. Blalock is interested in a proposed ditch, 60 ft. wide, to tap the Spokane River near this place, and to irrigate land in Franklin and Adams counties.

FRESNO, CAL.—J. H. Smith, Portland, Ore., to whom the contract for the Sunset canal was awarded, at $1,380,000, has awarded a contract for machinery to the Stilwell-Bierce & Smith-Vaile Co., Dayton, O., at $100,000; also, a contract for pipe lines, at about $500,000.

VICTOR, CAL.—It is reported that the Victor Reservoir Co. will dam the Mojave River and create an artificial lake 9 miles long and 3 miles wide, to irrigate 200,000 acres of land in southern California.

NEW COMPANIES.—Columbia Irrigation Co., Pendleton, Ore., $250,000; J. M. Leezer, B. S. Burroughs, Jesse Failing.—Lake View Water Co., Redlands, Cal.; $1,000,000; F. E. Brown, E. G. Judson, R. J. Waters.—Snake Valley Land & Water Co., Salt Lake City, Utah; $500,000; Pres., Jas. A. Melville; Vice-Pres., R. T. Pettengill; Treas., Jas. W. Searles.

### SEWERS.

BELMONT, MASS.—Frederic Dodge has been elected chairman of a committee to investigate a system. It is reported that an engineer will be employed to prepare plans and estimates.

BOSTON, MASS.—The metropolitan sewerage commissioners will receive bids until June 3 for sections 30 and 44 of the main sewer, and until July 1 for a pumping station at Charlestown, as stated in our advertising columns.—The superintendent of streets will receive bids until June 7 for two sewers.

BROCKTON, MASS.—The contracts for sections 6 and 7 of the intercepting sewer have been awarded to Moulton & O'Mahoney, Boston, at $30,815 and $31,781, respectively. The other bids were: Everson & Liddle, $32,589 and $32,330; Jones & Meehan, $37,310 and $35,892; National Construction Co., $34,774 and $32,568; A. W. Bryne, $38,175 and $39,814; Dennis O'Connell, $32,931 for section 6; Maney, O'Connor & White, $38,962 for section 6.

CANTON, MASS.—The question of constructing a system is being discussed.

LYNN, MASS.—It is reported that sewers will be constructed in several streets in West Lynn.

MALDEN, MASS.—A sewerage loan on $100,000 has been voted.

NEWBURYPORT, MASS.—Bids are asked until May 29 for sewers in two wards. G. H. Stevens, Cy. Clk.

TAUNTON, MASS.—The aldermen have voted to borrow $15,000 for drains and sewers.

NEW HAVEN, CONN.—Bids are asked in another column for about 3,000 lin. ft. of brick sewer.

ILION, N. Y.—The sewerage commissioners will receive bids until June 6 for about 10.6 miles of pipe sewers, as stated in our advertising columns.

MEDINA, N. Y.—Bids are asked until June 15 for 2.5 miles of 24 to 8-in. pipe sewer; average cut, 9 ft.; estimated cost, $13,000. Edward Posson, Clk. Sewer Comn.

RYE, N. Y.—John Bogart has recommended a separate system to cost about $50,000.

NEWARK, N. J.—The city surveyor has prepared plans for a sewer in the lower part of the city, including 11,227 ft. of main sewer to cost about $143,458. He recommends that work to cost $108,183 be constructed this summer.

CARBONDALE, PA.—The city clerk will receive bids until June 5 for about 14,000 lin. ft. of pipe sewers, as stated in our advertising columns.

NANTICOKE, PA.—S. Williams, Jr., Supt. of Sewers, informs us that a contract for 33,000 ft. of 24 to 6-in. pipe sewers has been awarded to Ferguson & Rooney, Wilkes-Barre, at $28,000.—Coon & Mooney, Wilkes-Barre, have just completed 3,200 ft. of 34×48-in. brick sewer, costing $22,000.

WILMINGTON, DEL.—Bids are asked until June 8 for 11,000 ft. of pipe and 5,300 ft. of brick sewers, as stated in our advertising columns.

WASHINGTON, D. C.—The district commissioners will receive bids until June 3 for sewer pipe and branches, vitrified invert bricks and invert blocks.

CHARLESTON, S. C.—Capt. R. F. Hartford has recommended a separate system of sewers, and that a complete system of drains be immediately constructed, about 25 miles of pipe, to cost about $200,000.

WEST END, GA.—An election will be held Jan 12 to vote on the issue of bonds for $50,000 for sewers, etc.

NEW ORLEANS, LA.—The city council has passed the ordinances for a drainage system, and for a topographical survey of the city.

NASHVILLE, TENN.—We are informed by J. A. Jowett, Cy. Engr., that the following bids were received May 16 for the Lick Branch sewer: W. G. Bush & Co., Nashville, section A, $81,698; B, $69,023; C, $56,880; D, $72,978; E, $58,825; total, $339,405.

Connor & Gianini, Pittsburg, Pa., sec. A, $92,464; B, $61,761; C, $49,062; D, $60,286; E, $47,231; total, $310,803..

Foster & Creighton, Nashville, sec. A, $78,495; B, $67,905; C, $56,573; D, $72,555; E, $58,787; total, $334,316.

Lesueur & Hutchison, Nashville, sec. A, $69,397; B, $57,652; C, $47,893; D, $60,160; E, $47,169; total, $273,804.

Frank Whitley, Springfield, O., sec. A, $87,300; B, $67,344; C, $54,935; D, $67,549; E, $52,221; total, $329,351.

Fulcher & Dyas, Nashville, sec. A, $82,431; B, $69,207; C, $57,745; D, $74,215; E, $59,037; total, $343,567.

Howard Neely & Co., Chattanooga, sec. A, $90,237; B, $57,962; C, $54,830; D, $74,772; E, $50,872; total, $318,000.

Aetna Construction Co., Columbus, O., sec. A, $83,653; B, $66,292; C, $52,142; D, $64,361; E, $51,740; total, $318,188.

B. D. Barton, Port Huron, Mich., sec. A, $80,122; B, $72,475; C, $57,679; D, $70,835; E, $55,507; total, $345,618.

Ryan & Shea, Nashville, sec. A, $82,000; B, $62,550; C, $53,400; D, $61,300; E, $47,900; total, $289,000.

Rockford Construction Co., Rockford, Ill., sec. A, $91,206; B, $75,252; C, $60,244; D, $75,179; E, $59,246; total, $361,127.

CHILLICOTHE, O.—The city council is considering a proposition of the Lewis-Mercer Construction Co., New York.

HAMILTON, O.—The council is considering a proposition to issue bonds for $200,000 for sewers.

VAN WERT, O.—John W. Hill, Cincinnati, has been engaged to prepare plans for a general system of sewerage.

ST. JOSEPH, MICH.—Bids are asked in our advertising columns for 12,000 ft. of sewers. A. V. Powell, Consult. Engr., Chicago.

CHICAGO, ILL.—Bids will soon be asked for a sewer in Wentworth Ave., between 87th St. and Calumet River.

JANESVILLE, WIS.—The special committee, referred to last week, has recommended that the council construct a system at once, according to the plans of Chas. F. Loweth, St. Paul.

MARINETTE, WIS.—Contracts have been awarded as follows: Donald McLeod & Co., Port Huron, Mich., $50,000; Wm. Campbell, Menominee, $4,000.

WATERTOWN, WIS.—W. F. Goodhue, Milwaukee, is preparing plans and specifications for a system.

FORT DODGE, IA.—Bids are asked until June 15 for sewers, including 4,239 ft. of 12-in. pipe, as stated in our advertising columns.

ST. PAUL, MINN.—A contract has been awarded to Kirkland & Starkey, at $46,377.

OMAHA, NEB.—The bids for the main sewer in 23d St. have been rejected, and the work will be readvertised.

WACO, TEX.—Bids will soon be asked for sewers for which $25,000 has been appropriated. Stephen Turner, Cy. Engr.

SALINA, CAL.—It is proposed to issue bonds for $30,000 for a system.

### STREETS.

HOPEDALE, MASS.—A contract for rebuilding several streets has been awarded to G. Cenedella, Milford, at about $12,000.

BROOKLYN, N. Y.—Bids are asked until May 31 for paving with cobblestones. J. P. Adams, Comr. Cy. Wks. Works.

NEW ROCHELLE, N. Y.—Bids are asked until June 10 for paving 7,000 sq. yds. with Belgian blocks. De Luze & Emmet, Engrs.

TONAWANDA, N. Y.—The aldermen of South Tonawanda have held a hearing on the proposed paving of Delaware St.; estimated cost, $82,000.

SALAMANCA, N. Y.—It is reported that Main St. will be paved.

NEWARK, N. J.—Bids are asked until May 29 for paving 8,000 sq. yds. with Trinidad Lake asphalt. Chas. Marsh, Supt. of Wks.

HUNTINGDON, PA.—The citizens have voted to issue bonds for $50,000 for telford paving.

CARBONDALE, PA.—Bids are asked until June 5 for paving with vitrified brick. Walter Frick, Cy. Engr.

NASHVILLE, TENN.—The board of public works will receive bids until May 30 for paving in three streets with granite blocks.

ASHTABULA, O.—The contract for paving Main St. has been awarded to Gardner & Barnett, Akron, at $14,854.

BELLEVILLE, MO.—The council has appropriated $23,000 for streets.

SALT LAKE CITY, UTAH.—The following bids were received for 69,616 sq. ft. of 4-in., and 103,440 sq. ft. of 6-in. sidewalk pavements: Houlahan, Griffith & Morris, $11,817 for 4-in. and $21,722 for 6-in.; Goodwin, Stembel & Co., $12,512 and $22,766; Frank Harrigan, $11,817 and $19,653.

### ELECTRIC LIGHT AND POWER.

HARTFORD, CONN.—The water privilege at Spoonville, on the Farmington River, located in the towns of Bloomfield, East Granby and Simsbury, has been purchased by A. C. Dunham, E. C. Terry, and others, and it is reported that an electric power plant will be established. Wm. W. Hyde, Mayor, can furnish particulars.

HAVRE DE GRACE, MD.—It is reported that the city council has voted to ask for bids for electric lighting.

ELBERTON, GA.—It is reported that a municipal lighting plant will soon be constructed.

OGLETHORPE, GA.—J. R. Cook is interested in a proposed plant.

QUINCY, FLA.—The town council desires electric street lights. W. H. Ellis is a member of the committee appointed to secure information and propositions. C. Munro, Eufaula, Ala., has offered to furnish ten lights of 2,000 c. p. each for $1,000 per year.

MADISONVILLE, O.—A special election will be held to vote on the question of a municipal lighting plant.

NAPOLEON, O.—Bids are asked until June 20 for a 150-HP. engine, dynamos, etc., as stated in our advertising columns.

INDIANAPOLIS, IND.—The contract of the town of West Indianapolis with the Indianapolis Light & Power Co. expires in July, and the town is reported as in favor of a municipal plant. The present price is $100 per lamp per year. Address John Pierson, Trustee.

WINCHESTER, ILL.—The Winchester Electric Light Co. has been incorporated to operate a plant.

ADRIAN, MINN.—The citizens have voted 122 to 76 in favor of issuing bonds for a lighting plant.

KIRKWOOD, MO.—A franchise has been granted to the Suburban Electric Lighting & Power Co., the plant to be in operation within six months.

NEEDLES, CAL.—It is reported that a lighting plant will be put in.

SANTA MONICA, CAL.—An electric light franchise will soon be awarded to the highest bidder. H. W. Carter has applied for it.

NEW COMPANIES.—Nazareth Electric Light & Power Co., Nazareth, Pa.; $10,000; Treas., A. K. Erdman.—Lackawanna Valley Electric Light & Power Co., Mayfield, Pa.; $150,000; Edwin M. Stalker.—Ruggles-Coles Engineering Co., Bayonne, N. J.; $10,000; W. H. Ruggles, T. C. Wellman.—Pumpelly-Sorely Storage Battery Co., Chicago; $500,000; Harriet M. Gibbs, Jessie M. Rowe, George H. Jenney.

### CONTRACT PRICES.

SEWERS.—Kansas City, Kan.—The following bids have been received for a sewer in one district, the prices being given in this order: 1, 10-in. pipe; 2, 12-in. pipe; 3, 15-in. pipe; 4, catch-basins; 5, manholes:

| | 1. | 2. | 3. | 4. | 5. |
|---|---|---|---|---|---|
| E. H. Bradbury | 63 cts. | 71 cts. | 83 cts. | $33 | $28 |
| John Maloney | 69.6 cts. | 82.4 cts. | 87.7 cts. | 35 | 30 |
| R. E. Ela | 62 cts. | 65 cts. | 85 cts. | 28 | 24 |
| C. Gustafson | 65 cts. | 75 cts. | 85 cts. | 33 | 29 |
| R. T. Mooney | 70 cts. | 73 cts. | 87 cts. | 33 | 27 |

Boston, Mass.—Bids were opened May 13 for section 43½ of the metropolitan main sewer, in Medford and Somerville. The work is as follows: 1, earth excavation and refill, 36×43 ins. and 35×42 ins., 2,315 lin. ft.; 2, brick masonry, American, 480 cu. yds.; 3, Portland, 170 cu. yds.; 4, concrete masonry, American, 260 cu. yds.; 5, Portland, 130 cu. yds.; 6, spruce lumber in place, 10 M. ft., B. M. The itemized prices follow:

| | 1. | 2. | 3. | 4. | 5. | 6. |
|---|---|---|---|---|---|---|
| Everson & Liddle, Providence, R. I. | $4.50 | $13.00 | $14.50 | $6.50 | $7.50 | $30 |
| Dennis O'Connell, Dorchester, Mass. | 3.25 | 13.25 | 15.00 | 6.00 | 7.00 | 38 |
| Metropolitan Cons. Co., Boston | 3.25 | 12.50 | 14.25 | 5.75 | 7.50 | 40 |

Newton, Mass.—The contracts for sections 6 and 8 of the city sewer system have been awarded to (1) Frank L. Allen, Worcester, at $30,617 and $7,402, respectively, as noted last week, the other bids being (2) Jones & Meehan, Jamaica Plains, and (3) National Construction Co., Boston. The prices for section 6 were as follows:

| | | | 1. | 2. | 3. |
|---|---|---|---|---|---|
| Earth excav. | 0 to 8 ft. | 11,040 cu. yds., at | $0.50 | $0.70 | $0.62 |
| " " | 8 " 14 " | 3,430 " " " | 0.70 | 1.10 | 0.88 |
| " " | 14 " 20 " | 170 " " " | 1.00 | 1.20 | 1.25 |
| " " | 20 " 26 " | 50 " " " | 1.25 | 1.80 | 2.40 |
| Rock excav. | 0 " 8 " | 1,670 " " " | 4.50 | 5.00 | 5.80 |
| " " | 8 " 14 " | 880 " " " | 5.00 | 6.50 | 6.70 |
| " " | 14 " 20 " | 100 " " " | 5.50 | 8.00 | 7.50 |
| " " | 20 " 26 " | 50 " " " | 6.00 | 10.00 | 9.00 |
| Brick masonry | | 300 " " " | 6.00 | 6.00 | 7.50 |
| Concrete masonry | | 40 " " " | 4.00 | 5.00 | 5.80 |
| Rubble stone masonry | | 40 " " " | 4.00 | 5.00 | 8.00 |
| Pipe sewers | | 7,000 lin. ft. " | 0.07 | 0.10 | 0.16 |
| " " | with jute. | 10,500 " " " | 0.09 | 0.12 | 0.22 |
| Pipe chimneys | | 200 " " " | 0.07 | 0.05 | 0.20 |
| " | sub-drains | 17,500 " " " | 0.25 | 0.30 | 0.32 |
| Spruce lumber, in place | | 5 M. ft. B. M. " | 35.00 | 30.00 | 40.00 |
| Spruce piles, in place | | 100 lin. ft. " | 0.50 | 0.30 | 0.25 |

WELL.—Aiken, S. C.—The contract for an 8-in. artesian well has been awarded to J. W. Baum, Atlanta, at $3.75 per ft. through clay or sand, and $4.57 through rock or quicksand, the contractor guaranteeing to secure a sufficient supply of water inside of 500 ft.

DREDGING.—Wilmington, Del.—The following bids were received by Wm. F. Smith, U. S. Engineer Office, for dredging in Cambridge harbor, Md.: Frank C. Somers, Camden, N. J., 12 cts. per cu. yd.; Fred. L. Somers, Philadelphia, 15.5 cts.; Chester T. Caler, Norfolk, 9.5 cts.; American Dredging Co., Philadelphia, 9.4 cts.; Baltimore Dredging Co., Baltimore, 18 cts.

PIPE.—Washington, D. C.—The following bids were received by the district commissioners for cast iron water pipe: Radford Pipe & Foundry Co., 3-in., $27.83 per ton; 4 and 6-in., $25.60; J. Drummond, 3-in., $29.25; 4-in., $27.25; 6-in., $26; R. D. Wood & Co., $31.75, $29.25, $28; McNeal Pipe & Foundry Co., $37.80 on cars or $36.50 on wharf, $35.30 or $34, $32.80 or $31.50.

Bangor, Me.—The contract for 7,500 lin. ft. of 20-in. pipe for the new water main has been awarded to the Harrison-Howard Iron Co., Bessemer, Ala., at $26.25 per ton for the pipe and 2.5 cts. per lb. for special castings.

GRANITE BLOCKS.—Lowell, Mass.—Contracts for granite paving blocks have been awarded to Edward Cawley, at $46.50 per M. for 400,000, and to P. F. Brady, at $46.50 for 400,000. The other bids were as follows: H. E. Fletcher, Westford, $46 per M. for 200,000; Brown Bros., N. Chelmsford, $48 for 125,000; Quincy Granite Co., $75 for 200,000; Pigeon Hill Co., $68.50 for 400,000; Bailey Suncook, $47 for 200,000; Miller & Luce, Quincy, $43.95 for 50,000, same for 100,000, $44.95 for 100,000 more and $45 for 150,000 in addition.

CEMENT, SEWER PIPE, ETC.—Newton, Mass.—Albert F. Noyes, Cy. Engr., informs us that bids for 1,000 bbls. of Portland cement ranged from $2.16 to $2.64 per bbl., and for 4,000 bbls. of American cement from $1 to $1.10 per bbl. The bids for sewer pipe offered a discount of from 61 to 76.5% from list prices. The prices for 250 cast iron manhole frames and covers ranged from $6.50 to $9.40 per set.

ASPHALT AND STONE BLOCK PAVING.—Ogden, Utah.—The following bids were opened May 8: Pacific Paving Co., Salt Lake City, curbing, $1.10 per lin. ft.; flagging, 77 cts. per sq. ft.; paving with stone blocks, $3.30 per sq. yd.; asphalt, $3.18 per sq. yd.: W. W. Funge, Ogden, $1.11, 78 cts., $3.30 and $3.09, re-

spectively; L. G. Wilkins, Ogden, $1, 75 cts., $3, $2.86; Corey Bros. Co., Ogden, $1.15, 70 cts., $3.15, $2.97; J. P. O'Neill, Ogden, $1.15, $1.10, $3.35, $3.20.

BRICK PAVING.—Erie, Pa.—Bids for paving 27,000 sq. yds. with brick ranged from $1.89 to $2.18 per sq. yd. for paving, including excavation, curb, etc.; or from $1.95 to $2.30 for the work complete, including catch-basins, etc. The bidders were the same as those for the work of which we published bids in our issue of May 4.

Greensburg, Pa.—The contract for the paving with vitrified brick, noted in our issue of May 11, has been awarded to R. T. Hallman & Sons, Washington, Pa., at $1.43 per sq yd. for paving, 50 cts. per lin. ft. for curbing and 20 cts. per cu. yd. for grading. This was the lowest of ten bids and is reported to be the lowest price ever paid for similar work in this place.

MISCELLANEOUS.

DOCKS.—Waukegan, Ill.—The North Waukegan Land Ass'n. has engaged A. V. Powell, Chicago, as consulting engineer for its proposed docks.

LEVEE WORK.—New Orleans, La.—The commissioners for the Lafourche Basin levee district will receive bids until June 5 for five sections of work.

IRON WORK.—Huntingdon, Pa.—Bids are asked until June 1 for the iron work for a cell house of 208 cells capacity at the Pennsylvania Industrial Reformatory. Samuel McCamant, Pres. Bd., Tyrone.

GARBAGE CREMATORY.—Auburn, N. Y.—The board of health will receive bids until June 5 for a garbage crematory; capacity, 25 cu. yds. in ten hours. John Gerin and J. E. McIntosh, Com.

WATER FRONT IMPROVEMENTS.—Stockton, Cal.—Plans have been prepared for water front improvements, estimated to cost $45,575. The work includes 1,425 ft. of bulkhead, 3,500 cu. yds. of grading and 202,000 cu. yds. of excavation.

GAS COMPANY.—Denver, Colo.—The National Gas Co. has been incorporated by David H. Moffatt, Stephen W. Dorsey, Geo. C. Corning, and others; capital stock, $1,000,000. The company has an option on the Stewart-Chicago patent.

DAM.—Ogden, Utah.—The Canyon Water & Power Co. has been incorporated by C. E. Mayne, David May and others, to build a dam across Ogden River, near this city. The water from the dam will be conveyed in 4-ft. pipes to a power house, where it is expected that sufficient power will be generated to supply this city and Salt Lake City. Work on the dam and power house will be commenced as soon as possible. The captal stock of the company is $250,000.

FERRY-HOUSE FOUNDATION.—San Francisco, Cal.—The contract for the foundation for the new ferry buildings, at the foot of Market St., has been awarded by the harbor board to the San Francisco Bridge Co., at $247,887, the other bids being as follows: Bigelow & Fogg, $346,000; California Bridge Co., $337,767; Doe, Hunt & Co., $297,000; McCann, McKay & Phillips, $290,000; McMahon & Son, $295,000; Cotton Bros., $317,227; Healey, Tibbetts & Co., $309,000.

LOCK.—Florence, Ala.—Bids were opened by Capt. Geo. W. Goethals, U. S. Engineer Office, May 15, for a lock 575 ft. long and 80 ft. wide, with a 25-ft. lift, on the proposed Colbert Shoals canal, below this city. The complete scheme calls for a canal 8 miles long, 150 ft. wide and 7 ft. deep in extreme low water, and is estimated to cost, when completed, $3,000,000. The bids ranged from $305,757 to $624,634, the lowest being as follows: T. A. Clark, Quincy, Ill., $305,757; Dunn, Lallande & Co., Birmingham, $320,119; M. M. V. Henry, Birmingham, $343,342.

CRIB BULKHEAD, ETC.—New York, N. Y.—The department of docks will receive bids until May 31 for a new crib bulkhead, 96,000 cu. ft., adjoining the storehouse dock, Blackwell's Island, for building a boat landing and for dredging about 800 cu. yds. The secretary has been directed to advertise for crib work estimated to cost $150,000 and embankment to cost $80,000.—The department of public parks will receive bids until May 31 for repairing and protecting the foundation and masonry of the sea wall in front of Castle Garden and grounds adjoining in Battery Park; also, for Portland cement paving, edgestones, etc., in Battery Park.

DREDGING, ETC.—Washington, D. C.—The U. S. Engineer Corps is advertising for bids, to be received until the dates specified: Dikes and dams, Cincinnati, May 29; dredging, Black River, Mich., May 31; dredging, St. Mary's River, Mich., June 10; iron work, Cincinnati, July 10; propeller, Galveston, Tex., June 12; building, Cincinnati, June 14.—The Supervising Architect is advertising the following work: Elevator work, Trenton, N. J., May 31; heating apparatus, Philadelphia, May 31; repairs, etc., Cairo, Ill., June 2; excavation, etc., Chester, Pa., June 2; repairs, Lake View, Chicago, June 2; stone and iron work, Fort Worth, Tex., June 9; wharf, etc., Port Townsend, Wash., June 13.

## INDUSTRIAL NOTES.

LOCOMOTIVES.—The Baldwin Locomotive Works, Philadelphia, Pa., have an order for ten Vauclain four-cylinder compound engines for the Missouri, Kansas & Texas; nine ten-wheel engines with cylinders 14 × 24 and 24 × 24 ins., and driving wheels 5 ft. 8 ins. diameter, and one consolidation freight engine with cylinders 14 × 26 and 24 × 26 ins., and driving wheels 4 ft. 8 ins. diameter. The works have also an order of 30 engines for the Missouri Pacific.

The Chicago & West Michigan will add 10 ten-wheel freight engines and 4 six-wheel switching engines to its equipment.

The Southern Pacific will add to its equipment 14 ten-wheel passenger engines, 8 switching engines and 3 twelve-wheel or mastodon compound engines for mountain freight service.

CARS.—The Litchfield Car Mfg. Co., Litchfield, Ill., has built a fish car for the Wisconsin Fish Commssion; this is the fourth fish car built at these works.

The Wagner Palace Car Co., Buffalo, N. Y., is building two dining cars for the New York, Chicago & St. Louis.

The Missouri Pacific has placed an order for 20 day cars, 10 chair cars and 4 mail cars.

The Chicago & West Michigan will add to its equipment 1,000 box cars, 200 flat cars, 7 cabooses and 10 passenger cars.

The Southern Pacific will build 500 freight cars at its shops at Sacramento, Cal., and will add 12 Pullman sleeping cars to its equipment.

The Bancroft Vestibule Car Co. has been organized at Chicago, Ill., with a capital stock of $100,000, by George W. Bancroft and M. E. Cole.

The Cotton Oil Refining Co., Baltimore, Md., wants tank cars of 6,000 gallons capacity.

ROCK CRUSHER.—The city of Quincy, Ill., will purchase a rock crusher. E. R. Chatten, Cy. Engr.

THE YOUNG NUT LOCK CO. has been organized, with Mr. Treat, of Chicago, as President, and Mr. Robert Haslett, as Treasurer. The company's office is at 150 Broadway, New York.

THE BEAMLESS BRAKE CO., Bloomsburg, Pa., has brought out an arrangement of brake gear designed to prevent accidents due to broken brakebeams. The brakes are hung from curved arms projecting in front of each wheel. The curved arm is made of malleable iron, and is supported by the extended archbars of the truck frames. It is connected by a rod to the usual brake levers, and any pattern of brake shoe can be applied. There are no expensive hangers and no safety chains. The arrangement is said to cost much less to apply than any brakebeam, and the wheel base can be 10 ins. shorter than where the brakes hang between the wheels. The beamless brake has been tested in actual service, and a car equipped with this attachment is in the Bloomsburg Car Co.'s exhibit in the Transportation Building at the World's Columbian Exposition.

THE KING BRIDGE CO., Cleveland, O., states that although it has sustained some damage to the riveting department by reason of fire, the power plant, machine shop and forge department were, with very slight exception, uninjured, and are running as usual. It expects to complete contracts it has on hand promptly, and any new ones it may obtain. The company will also at once commence the construction of an entirely new riveting department, which will be of fire proof construction, and in every way a model of its kind.

THE GEORGE F. BLAKE MFG. CO., of New York, provided the new armored cruiser "New York" with an entire outfit of Blake pumps, including special air-pumps for the main engines. These air-pumps are said to have done some remarkable service in the preliminary and official tests of this now famous warship, whose trial is noted elsewhere.

THE UNION SWITCH AND SIGNAL CO., of Swissdale, Pa., has just commenced the installation of its automatic electric system of signals upon the Lake Shore & Michigan Southern, between Toledo and Buffalo, and it is expected that the Lake Shore will extend the use of these signals over its whole system. The company is also now equipping its Niagara Falls branch and the New York Central line to Buffalo with the block system. The work is now completed to within 50 miles of Buffalo, and it is said that the system will be extended over the Lake Shore road to Chicago.

NEW COMPANIES.—The Standard Automatic Railway Signal Co., Newark, N. J.; $100,000; J. Wayland and J. H. Fleming, of Newark; C. B. Day, of East Orange. Edwin S. Jackman Co., Chicago, Ill.; railway supplies; $50,000; Edwin S. Jackman, A. W. Barnum and H. C. Letshaw. Newburn Brick Works Co., Newburn, Ill.; $150,000; W. W. Courtney, G. H. Smiley and Levi Davis.

## NOTICE TO SEWER CONTRACTORS.

ILION, N. Y., SEWERAGE.

Sealed proposals will be received by the Board of Sewer Commissioners of the Village of Ilion until June 6th, 1893, at noon, for the construction of a sewerage system for said village, consisting of furnishing and laying about 10.6 miles of vitrified sewer pipe, with its branches, and the construction of about 109 manholes, 78 lampholes, 40 flush tanks, and other appurtenances.

Bids will be received for the entire work. Plans may be seen at the office of the Commission, Ilion, N. Y., and specifications procured of Anthony Steber, Secretary, on and after May 22nd, 1893.

The Board of Sewer Commissioners hereby reserve the right to reject any or all bids, or to accept any that in their judgment will be for the best interests of the village.

Bonds satisfactory to the Board in amount and sureties will be required of the one to whom the contract may be awarded.

Cash or a certified check, made payable to the Board of Sewer Commissioners of Ilion, N. Y., to the amount of $500 must accompany each bid as a guarantee that, in case the contract is awarded, the party or parties to whom the award is made will, within five days after notification of award, execute said contract.

Bids must be sealed and addressed to Anthony Steber, Secretary of Sewer Commissioners, Ilion, N. Y., and marked "Proposal for Sewer Construction."

JOHN HOEFLER, Pres't.
ANTHONY STEBER, Sec'y.
GEORGE F. WILCOX,
M. H. STERLING,
GEORGE WILFERT,
Board of Sewer Commissioners.

Ilion, N. Y., May 13, 1893. 21-2t

U. S. ENGINEER OFFICE, CUSTOM House, Cincinnati, Ohio, April 29, 1893.—Sealed proposals for building dikes and dams in the Ohio River at the following locations, or any one of them, viz.: 4 dikes and 1 dam and shore protection at Clusters, 2 dikes and 1 dam at French Island, 2 dikes near Scuffletown, 1 dike near mouth of Tidewater River, 2 dikes near Mound City, will be received at this office until 2:30 p. m., May 29, 1893, and then publicly opened. Specifications, blank forms, and all available information will be furnished on application to this office. AMOS STICKNEY, Major of Engineers, U. S. A. 18-4t

## DUNKIRK WATER-WORKS.

NOTICE TO BIDDERS.

Sealed Proposals will be received by the Board of Water Commissioners of the City of Dunkirk, N. Y., at their office in said city until 12 o'clock noon, of Wednesday, June 7th, 1893, for furnishing approximately 5,100 lineal feet, 510 tons, of 24-in. pipe; 100 feet, 12 tons of 30-inch pipe, and 11 tons of special castings. Also, two 24-inch valves and one 30-inch valve. Also for laying said pipe, approximately, 3,800 lineal feet of which to be laid in open trench, excavated and back filled, and 1,300 lineal feet to be submerged.

The whole to be laid two feet below low water in Lake Erie, measuring from the top of pipe. Also one submerged intake crib, to be constructed of timber, with stone filling, rip-rap, etc. Also one circular brick pump well, 25 feet diameter and 30 feet deep.

Bids will be received in aggregate for the whole work including the furnishing of all materials and labor, also in detail. Aggregate bids must give prices for all materials contemplated by such bids, and the Commissioners reserve the right to furnish the cast iron pipe, special castings and valves.

Each bidder will be required to deposit a certified check, or cash to the amount of 10 per cent. of bid, as an evidence of good faith.

Detailed drawings will be ready for the examination of bidders from and after the 20th inst., from and after which date also specifications, forms of proposal and forms of contract will be furnished.

The Commissioners reserve the right to reject any or all bids.

R. L. CARY, President,
JOHN MADIGAN, Secretary,
WM. BOOKSTAVER,
LOUIS HEYL,
CHARLES J. CARNEY,
WM. H. WYMAN,
M. J. O'DONNELL,
Commissioners.

J. D. COOK,
Consulting Engineer, Toledo, O.

Dunkirk, N. Y., May 18, 1893. 21-2t

## TOWN OF CICERO.

PROPOSALS FOR CAST IRON PIPE, ETC.

Sealed proposals in duplicate (said proposals to be addressed as follows: Original to the Town Clerk,—duplicate to the President of the Town to whom it must be delivered) are invited for furnishing and laying 6,550 feet of 10-inch cast iron water pipe, 24,900 feet of 8-inch cast iron water pipe, 56,100 feet of 6-inch cast iron water pipe, 20,300 feet of 4-inch cast iron water pipe, 4 10-inch valves, 21 8-inch valves, 51 6-inch valves, 29 4-inch valves; also, furnishing and laying 1,900 feet 4-inch cast iron water pipe, 3 4-inch valves, in the Town of Cicero, Cook Co., Ill., in accordance with the ordinances, profiles and specifications now on file in the Engineer's office.

Payment for said work to be made from special assessments when collected.

Bids will be received until 12 m., Friday, June 22d, 1893. A certified check for 10 per cent. of the amount of the bid must accompany the proposal marked original.

The Board of Trustees of the Town of Cicero reserve the right to reject any or all bids.

ED. S. AUSTIN,
Town Clerk.

Austin, Ill., May 16th., 1893. 21-4t

## TO PAVING CONTRACTORS.

Sealed proposals will be received by the City Clerk of Carbondale, Pa., until June 5th. 1893, at 8 o'clock, p. m., for the furnishing of material and labor for the paving, with vitrified brick, Church Street, in the City of Carbondale, according to plans and specifications on file in the City Engineer's office, City Hall.

Bidders will be required to inclose cash or certified check equal to 5 per cent. of the amount of bid as a guarantee of good faith and that they will enter into a contract within ten days if awarded the same.

The city reserves the right to reject any or all bids.

THOS. L. McMILLAN,
City Clerk.
WALTER FRICK,
City Engr.

Carbondale, Pa., May 22, 1893. 21-2t